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CONTENTS

CONTRIBUTIONS, ABSTRACTS, AND BIBLIOGRAPHY

	Page
PAPERS ON THE RELATION OF THE ATMOSPHERE TO HUMAN COMFORT:	
Introductory note. C. F. Brooks	423
The cooling of man under various weather conditions. C. F. Brooks	423
Human comfort as a basis for classifying weather. E. C. Donnelly. (2 figs.)	425
The summer and winter weather of selected cities in North America. George F. Howe. (4 figs.)	427
A classification of weather types. E. S. Nichols	431
Weather types in the climates of Mexico, the Canal Zone, and Cuba. J. Elmer Switzer. (1 fig.)	434
Tornadoes in Alabama. Welby R. Stevens. (6 figs.)	437
The prediction of minimum temperatures for the Red River Valley. Albert W. Cook. (3 figs.)	443
A short method of determining the time of moonrise and moonset. F. N. Hibbard	447
NOTES, ABSTRACTS, AND REVIEWS:	
Daylight illumination on a sloping surface—a correction. H. H. Kimball	448
The big trees as a climatic measure. Ernest Antevs	449
Tornado in southeastern Alabama. B. M. V	450
Meteorological summary for southern South America, October, 1925. J. B. Navarrete	450
BIBLIOGRAPHY:	
Recent additions to the Weather Bureau library	450
Recent papers bearing on meteorology	451
SOLAR OBSERVATIONS:	
Solar and sky radiation measurements during October, 1925	452

WEATHER OF THE MONTH

	Page
WEATHER OF NORTH AMERICA AND ADJACENT OCEANS:†	
North Atlantic Ocean	453
Table of ocean gales and storms, October, 1925	455
North Pacific Ocean	456
A depression and a typhoon over the Philippines in October, 1925. J. Coronas	456
DETAILS OF THE WEATHER IN THE UNITED STATES:	
General conditions	457
Cyclones and anticyclones	457
Free-air summary	457
The weather elements	459
Table of severe local hail and wind storms	461
Storms and weather warnings	462
Rivers and floods	464
Great Lakes levels, October, 1925	465
Effect of weather on crops and farming operations	465
TABLES:	
Climatological tables	466
Canadian data	470

CHARTS

	Serial number
I. Tracks of centers of anticyclonic areas	101
II. Tracks of centers of cyclonic areas	102
III. Departure (°F.) of mean temperature from the normal	103
IV. Total precipitation, inches	104
V. Percentage of clear sky between sunrise and sunset	105
VI. Isobars at sea level and isotherms at surface; prevailing winds	106
VII. Total snowfall, inches	107
VIII–XIII. Weather maps of North Atlantic Ocean, October 10–11 and 19–22, 1925	108–113
W. R. S.–3. Tornado tracks, Alabama, 1794–March, 1925	114

† In marine separate.

MONTHLY WEATHER REVIEW

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PAPERS ON THE RELATION OF THE ATMOSPHERE TO HUMAN COMFORT

The following group of five papers represent an experiment in the treatment of climatic data. Even two decades ago climatologists had carried the separation of climatic data into the elements so far that a swing toward synthesizing them was made. Prof. R. De C. Ward has vivified American climates in his extensive discussion, The Weather Element in American Climates.[1] The next step was, obviously, to express our weather in terms of a scale of human comfort, or at least to describe climates with the aid of frequencies of well-recognized weather types. The first two papers are but suggestions of lines along which may be developed a satisfactory scale of human comfort in terms of weather. The other three papers illustrate three types of treatment of climate as the aggregate or succession of daily weather.—*C. F. B.*

[1] Annals of the Association of American Geographers, Vol. IV, pp. 3-54, 1915.

THE COOLING OF MAN UNDER VARIOUS WEATHER CONDITIONS

By C. F. Brooks

[Clark University, Worcester, Mass., 1922]

Dr. Leonard Hill, in his recent work, The Science of Ventilation and Open Air Treatment,[1] has compiled a great deal of information concerning the rate at which a man cools under various weather conditions. Valuable though this material is, however, the various experiments and observations have not been coordinated into any systematic statement of the cooling power of the atmosphere on man.

In this paper an attempt has been made to reduce these observations to a mathematical form, in an effort to find a basis by which weather might be classified according to its relation to human comfort. No claim is made that the formulæ and tables deduced are of satisfactory accuracy, but merely that the method employed and the application made (see Donnelly's paper, following) justifies the collection of more experimental data so that accurate studies of the relations of weather to man may be made on these lines.

The human cooling data presented by Hill are of three sorts: (1) Calorimetric observations by Lefevre, (2) metabolism (Douglas bag) observations by Hill and his associates, and (3) human comfort observations in conjunction with those of the katathermometer and various weather factors.

(1) The calorimetric observations by Lefevre were for various temperatures between −1 and +20° C., on a subject naked and clothed, with wind velocities of 3.5 meters per second, and on a subject clothed, with a wind velocity of 1 meter per second. (Tables 15 and 16, Hill, Pt. I, pp. 45–46.) These data represent the actual output of heat from the man's body (C_m). They may be given fairly accurately by the following formula (for clothed man):

$$C_m=\left(\frac{19.5-\theta_1}{603}+\frac{3.0+\theta_1}{222}\sqrt{v}\right)(0.10+0.40/\sqrt{v})\theta_1+0.35$$

in which θ_1, is the depression of the air temperature below 36.5° C., v the wind velocity in meters per second, and the last term the assumed loss of heat from the lungs and skin owing to evaporation (in millicalories per square centimeter of body surface per second). A table showing smoothed values derived from this formula is presented in the second paper of this group.

(2) The metabolism observations by Hill and his associates are given principally in Tables 31 and 32, Part I, pages 90–93. Here are presented the heat production of various subjects sitting out of doors in all kinds of weather at all seasons (H_m). Unfortunately, the data are not sufficiently extensive to be expressible in well-founded mathematical formulæ. Those obtained from plotted data, to which lines were fitted by the eye rather than by the least square method (which was not used because of the insufficiency of the data) are as follows: $H_m=(0.025+0.004\sqrt{v})\ (0.10+0.40/\sqrt{v})\ \theta_1+0.35$ for velocities 0.25 to m/s. $H_m=(-0.016+0.08\sqrt{v})\ (0.10+0.40/\sqrt{v})\ \theta_1+0.35$ for velocities above 1 m/s. Except in warm weather, the rate of heat production by Hill and his subjects is less than the rate of heat emission by Lefevre's subjects.

(3) The comfort indications given in the latter portions of Hill's Part I have used as a rough check, when extrapolations were made, to derive tables for comparing the cooling power of various weather conditions.

With these data of heat emission, heat production, and comfort, it appeared possible to construct tables which would show for any weather conditions approximately the rate at which a man will cool. (See the second paper of this group.)

The indications of the katathermometer have not shown any simple relation to man's cooling. The reasons are several:

Man's heat regulatory apparatus varies with respect to:
First. The flow of blood through the surface capillaries;
Second. The rate of evaporation from the skin;
Third. The conductivity of the skin; and
Fourth. The temperature of the skin.

There are differences between subjects and between the basic conditions of the same subject at different times. Hill found, however, that if the kata had a temperature like that of the subject's cheek, the rate of cooling of the kata would be roughly 6.5 times the rate of heat production of a clothed man.

[1] Pt. I, Medical Research Committee, Spec. Report Ser., No. 32, 1919; Pt. II, Medical Research Council, Spec. Report Ser., No. 52, 1920, London, H. M. Stationery Office.

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If, then, it is possible to express cheek temperatures in terms of air temperature and wind velocity, it should be possible to express man's cooling by means of a meteorological formula. For all of Hill's data I plotted θ_2/θ_1 against $\sqrt{v}$, θ_2 being the depression of the cheek temperature below 36.5° C. (roughly blood temperature) and θ_1 the depression of the air temperature below 36.5° C., and v the wind velocity in meters per second. Locating a curve by eye, the following formula was obtained:

$$\theta_2 = (0.10 + 0.40\sqrt{v})\ \theta_1$$

Tables (see Table 1 and Figure 2 in the paper by Donnelly, following) were constructed from the formula derived from Lefevre's experiments, except for temperatures above 70° F., for which the dry katathermometer formula multiplied by a factor for clothing and divided by 10, was used. This factor for clothing was derived from various tables and statements in Hill's Part I, and is represented by the formula:

$$F = (8.5 - \sqrt{v}) \div 11.8$$

The factor 10, by which the kata indications were divided, was arbitrarily chosen, as it gave cooling powers which accorded well with those obtained from the Lefevre experiments. The reason for using a different formula above 70° F. was that it was not thought safe to extrapolate Lefevre's results to higher temperatures; while the justification for using the kata formula is that at such temperatures the skin temperature of the body (including the cheek) is likely to be but little below blood temperature.

For the effects of very high air temperatures and wind velocities at these temperatures, consult C. W. B. Normand in Quarterly Journal of Royal Meteorological Society, January, 1920, volume 46, pages 1–14, diagram. This article will provide a zero of cooling power for various wind velocities at temperatures above 100° F.

The effects of changing moisture and changing intensity of radiation were to be taken care of by additive terms: the moisture effects could be reasonably handled by using the wet-kata formula, $H' = (0.13 + 0.47\sqrt{v})\ \theta_1 + (0.35 + .098\sqrt[3]{v})\ (F - f)^{4/3}$ (see proceedings of the Royal Society B, 1922, vol. 93, pp. 198–206), minus the dry-kata formula $H = (0.13 + 0.47\sqrt{v})\ \theta_1$, multiplied by the factor for clothing $F = (8.5 - \sqrt{v}) \div 11.8$, divided by 10. It was recognized, however, that the temperature of the skin is more likely to depart from the blood temperature when the skin is wet than when it is try. As insufficient data were at hand, it was thought best not to attempt to evaluate this. The effect of changing vapor pressure on the evaporation from the lungs was recognized, but as the greatest changes to be found in most climates would vary with the cooling power above or below the average by the equivalent of but 0.05 millicalories per square centimeter of body surface, this factor was neglected.

The effect of sunshine and, on clear nights, of outgoing radiation was evaluated by comparing the maximum intensity of sunlight and radiation in the clearest weather, with the amount that could be received by a man standing vertically, and by dividing this by an arbitrary figure thought to be appropriate for the direct loss of heat from the surface of the clothing without appreciably affecting the body.

Thus, taking 1.4 gram-calories as the maximum intensity at normal incidence per square centimeter per minute (=1,400/60 =23 millicalories per square centimeter per second), the total heat (in millicalories per second per centimeter²) received by a man would be twenty-three times the area of a man's shadow on a plane normal to the sun's rays. With the sun at an altitude of 60° the receipt per square centimeter of body surface of a man of average size would average about 3.5 millicalories per second. Dividing by 2 or less, for the loss directly from the surface of the clothing, we have left only about 2 millicalories per square centimeter of body surface. Thus the factor taken was 2.0 x S, where S = bright sunshine in per cent of the possible sunshine for the day. For the conditions at a particular time a factor less than 2 should be taken if the sunshine is not at its brightest, while under conditions of bright sun shine and a snow cover or water surface a factor of 3.5 and 3, respectively, would be reasonable. On a clear night a negative factor of small degree, about −0.2, would generally show the cooling effect of net radiation.

Summary and outlook.—Our study of the physiological significance of weather types may be outlined and our hopes stated, briefly as follows:

Object.—To present climatic data in a form which has direct significance in any study of the comfort of man in any region at any time, and under any conditions of work and shelter.

Method.—It is necessary in considering the most obvious physiological effect of the weather to use (*a*) the rate of cooling as the unit so far as the weather is concerned and (*b*) the rate of heating so far as the man is concerned.

a. Rate of cooling.—The rate of cooling is a complex of the following factors:

(1) Air temperature (effects well worked out with katathermometer).

(2) Wind velocity (effects well worked out with katathermometer).

(3) Rate of evaporation from a man's body. (Average of 570 kg. cal. heat loss per 24 hours. Extremes vary with humidity, water imbibed, work performed, and air temperature.)

(4) Intensity of radiation (combined with air temperature).

(5) Clothing (variable).

b. The rate of heating involves the following:

(1) Metabolism from food recently eaten. (Variable, but an average may be used.)

(2) Work being performed. (Variable, but the heating effects of well-known sorts can be specified.)

(3) Sunlight and incoming sky radiation. (Variable with cloudiness, humidity, and solar altitude, and with color and texture of surface.)

(4) Air temperature when above 98.6° F. (Effect depends on wet-bulb temperature and wind velocity.)

(5) Wind velocity when air temperature is above 98.6° F. (Heating only when wet-bulb temperature rises above 98.6° F.)

Discussion of a practicable combination.—What we need are tables showing for any kind of weather the feeling of cooling which a man will experience under any degree of activity and in any kind of clothing. How near can we get to fulfilling this need? The factors, air temperature, wind velocity, metabolism, and work, can be taken care of to some extent, as indicated above. Doctor Hill has some data for these in his books. But other data are required. More calorimetric observations of the actual cooling and heating of man are required. It is hoped that this discussion will be helpful as a pioneering effort.

HUMAN COMFORT AS A BASIS FOR CLASSIFYING WEATHER*

By E. C. DONNELLY

[Clark University, Worcester, Mass., 1922]

The purpose of this paper is to attempt to classify the weather according to its bearing on human comfort. Usually, climates are described in terms of average and extreme conditions of such elements as temperature, vegetation of the region, or according to the altitude and latitude. In climatological literature we do not often find, however, that most interesting feature: The frequency and sequence of different weather types, and how these affect human comfort.

Human comfort as a basis of a classification will differ from mere temperature or humidity or wind or cloudiness or altitude or latitude inasmuch as a classification based on it depends directly on a combination of these factors rather than on any one of them. Hot dry weather can be borne better than hot damp weather.

In the classification given below, the factors of temperature, wind, sunshine, and evaporation form the basis.

A previous attempt was made by the writer to classify the weather according to combinations of the factors of temperature, sunshine, humidity, and winds. A scale was constructed by a simple arithmetical formula in which different combination were made and classified according to their effect on human comfort. This classification was applied to weather observations made at Worcester, Mass., and the result shown at the meeting of the American Meteorological Society at Toronto in December, 1921. The following note appeared in the Bulletin of the Society in April, 1922, page 63:

> An arbitrary scale of human discomfort was made from the various combinations of five classes of temperature, three of sunshine, two of wind, and three of humidity, and with this the daily weather at Worcester for the past three months was plotted. The preponderance of comfortable days in September and October stood in marked contrast to the numerous uncomfortable days in November and December. There was a change from the best (moderate, bright, quiet, and dry) on November 8 to the worst (cold, dull, windy, and damp) on the 9th.
>
> *Discussion.*—The question was raised as to whether Arizona weather could be shown on such a scale. The answer was that it could, and that it would show that most days, say, at Tucson, Ariz., would be more comfortable than many of those experienced in Worcester in winter and summer.

Later, the classification was applied to data from Phoenix, Ariz., and the Phoenix chart showed a distinct trend toward ideal conditions in the months from November to April and rather uncomfortable conditions during the summer months.

However, the above scheme was abandoned upon the suggestion of Dr. C. F. Brooks, because marked irregularity in the curve overemphasized the relative comfort of successive days, thus indicating that the basis of the classification was at fault.

In place of this classification it was suggested by Doctor Brooks that one might be worked up on the basis of the cooling powers as shown by the katathermometer readings. (For description of the katathermometer, see the MONTHLY WEATHER REVIEW for September and December, 1920.) To the values obtained from the katathermometer readings obtained from Leonard Hill's "The science of ventilation and open air treatment,"[1] values were to be added or substracted to account for the factors of sunshine and evaporation.

After many attempts, an empirical formula was devised. For temperatures below 70° F.:

$$C_m=\left(\frac{19.5-\vartheta_1}{603}+\frac{3.0+\vartheta_1}{222}\sqrt{v}\right)\left(0.10+\frac{0.40}{\sqrt{v}}\right)\vartheta_1+0.35+\underset{(2.0\times S)}{} \quad (1)$$

For temperatures above 70° F.:

$$C_m=(0.13+0.47\sqrt{v})\vartheta_1\frac{(8.5-\sqrt{v})}{11.8\times 10}+0.35+(2.0\times S) \quad (2)$$

This could be applied to data taken at any meteorological station of the Unitd States Weather Bureau (see preceding article by C. F. Brooks.)

Because of the pressure for time when these formulæ were finally derived, only one station was classified, namely, Los Angeles. (See fig. 1.) This station was taken in preference to others because if the oft-used expression, that Los Angeles has steady and almost Utopian climate, is true and the results upon the application of this formula indicated that the weather was seldom uncomfortable, then it might be inferred that the formula was of some value and consequently, of some potential use.

This curve also shows much steadier working conditions in the summer than in the winter. However, the curve by itself does not take into account the differences in the laboriousness of the task performed. Therefore at the right-hand end of the chart lines have been drawn, based on figures given in Leonard Hill's Science of Ventilation and Open Air Treatment, Part I, page 54, indicating the cooling power for a particular worker. Thus a man sawing wood would be uncomfortable nearly every day in the year, while a stone mason would be uncomfortable during the whole summer but could work with comfort during the winter months. A painter would not be uncomfortable at any time during the year if working in the shade, but would sweat on many days, both in summer and in winter, if he were painting in the sun. A shoemaker could work with comfort the year round provided he kept out of the sun; but during July and August conditions would be rather poor for work in the direct sunlight. According to these figures, a tailor has the most comfortable work of any of those given, for he is comfortable the year round when working in the shade and he would be uncomfortable only 43 days during the year even if he worked in the sun.

TABLE 1.—*Cooling powers (C_m) in millicalories per square centimeter per second for dry man at rest in the shade, Los Angeles, Calif.*[1]

Temperature	Wind velocity in miles per hour							
	2	4	7	10	15	20	25	30
°F.								
95	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
90	.5	.6	.6	.6	.6	.7	.7	.7
85	.6	.7	.7	.8	.8	.9	.9	.9
80	.7	.8	.9	.9	1.0	1.1	1.1	1.1
75	.8	.9	1.0	1.1	1.2	1.2	1.2	1.3
70	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5
65	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8
60	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2
55	1.7	1.9	2.0	2.1	2.3	2.4	2.5	2.7
50	2.0	2.2	2.3	2.5	2.7	2.8	3.0	3.3
45	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.8
40	2.6	2.8	3.1	3.4	3.6	3.8	4.1	4.4
35	2.9	3.2	3.6	3.9	4.2	4.4	4.7	5.0
30	3.2	3.6	4.1	4.4	4.8	5.0	5.3	5.6
25	3.6	4.1	4.6	4.9	5.4	5.7	6.0	6.3
20	4.0	4.6	5.1	5.5	6.0	6.4	6.8	7.2
15	4.4	5.1	5.6	6.1	6.7	7.2	7.6	8.1
10	4.8	5.6	6.2	6.8	7.4	8.0	8.5	9.0
5	5.3	6.1	6.9	7.5	8.2	8.9	9.4	9.9
0	5.8	6.7	7.6	8.3	9.1	9.8	10.5	11.3

[1] Values in this table were computed from the following formulæ, then smoothed: For temperatures (°F.) 0°–70°, $C_m=\left(\frac{19.5-\vartheta_1}{603}+\frac{3.0+\vartheta_1}{222}\sqrt{v}\right)(0.10+0.40\sqrt{v})\vartheta_1+0.35$. For temperatures 70°–95°, $C_m=(0.13+0.47\sqrt{v})\,\vartheta_1[(8.5-\sqrt{v})\,(11.8\times 10)]+0.35$.

*Part of thesis prepared under the direction of C. F. Brooks and presented as a portion of the requirements for the degree Master of Arts in Geography, Clark University.

[1] Two parts. London, 1919, 1920.

DISCUSSION OF THE CURVES

The dotted curve (see fig. 1) represents the cooling power of a man seated in the shade. In this Los Angeles region, the range of the cooling power is only 2 millicalories per square centimeter per second, thus showing a remarkable steadiness of the weather. From June 19 to September 20, the range was only 0.6 of a millicalorie and the curve indicates that the cooling power for this long period of time was sufficient to keep a man comfortable. The curve averages a cooling power of 1.2 while the ordinary rate of metabolism is 1.1, thus the weather of Los Angeles is just a little more than sufficient to compensate for the heat evolved by metabolism, thereby insuring comfort.

The dot-dash line represents the colling power of a man seated in the direct sunlight. The factor of sunshine has been substracted. (See preceding article by C. F. Brooks, for discussion of this factor.) For this reason the curve is much more jagged, showing that the sun does not shine for the maximum possible period every day in this locality. A man seated in the sunlight would be uncomfortable practically every day during the summer and many days even in the winter, provided his rate of metabolism remains constant at 1.1 millicalories per square centimeter per seond.

The broken black line is the curve in which most of us would be interested, for it gives the cooling power for a man working in the shade. This curve was derived by adding to the cooling power of a man at rest the value $(0.035+0.098\sqrt[3]{v})\ (F-f)^{4/3}$; F being the vapor pressure at 36.5° C. and f the vapor pressure at noon each day. This factor evaluated the maximum possible loss of heat through evaporation of sweat, by a man working in the shade. The solid black line on the chart shows the cooling power for a man working in the sun, the factor for sunshine having been subtracted.

A word here may be necessary to explain Table 1 and Figure 2. The table is based on formula (1) for temperatures below 70° F., and formula (2) for temperatures above 70° F. The table was smoothed after its completion. Figure 2 was constructed by working out values from the formula: $H^1=(.035+.098\sqrt[3]{v})\ (F-f)^{4/3}$, and the results were put into this graphic form in order that they might be easier to read in the case of figures for which values had to be interpolated.

CONCLUSION

From the excellent result of the application of the values obtained from the formulæ to data from Los Angeles, it is hoped that the result of this research will be used in connection with some plan by which working conditions can be made more pleasant. While the values given may or may not be of immediate use, yet they can be made the basis of further work. Possibly, when the values for enough cities have been charted, as Los Angeles has in this investigation, a basis for classifying the different sections of the United States could be made,

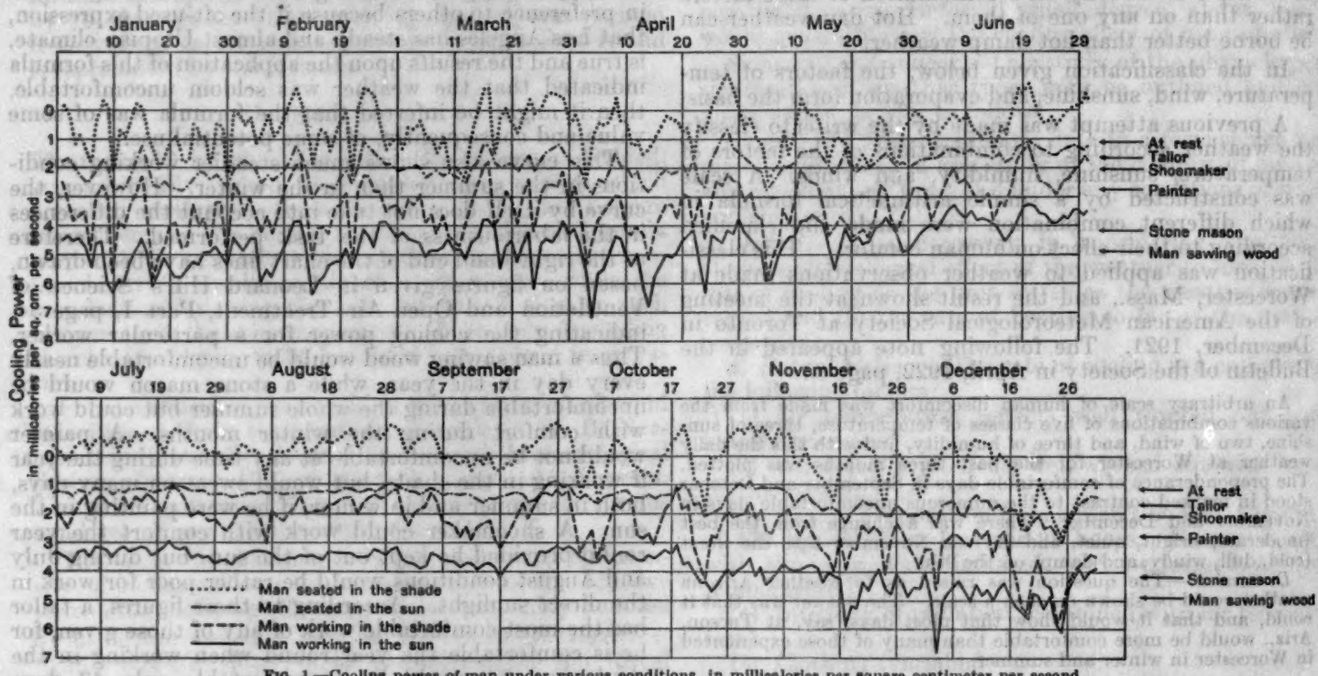


FIG. 1.—Cooling power of man under various conditions, in millicalories per square centimeter per second

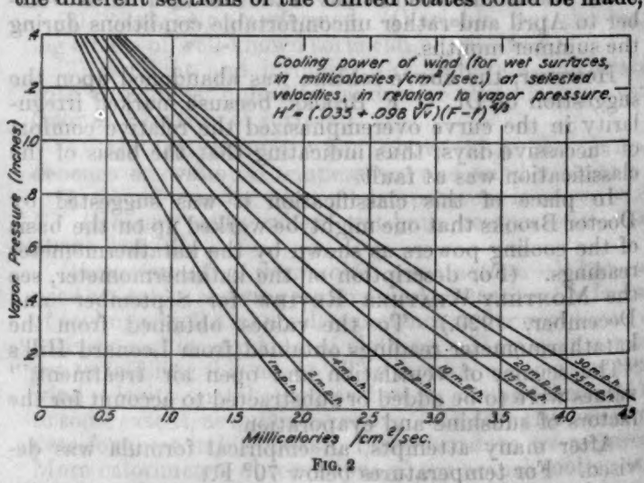


FIG. 2

which would be of great value to doctors and others interested in the relations of climate to health.

THE SUMMER AND WINTER WEATHER OF SELECTED CITIES IN NORTH AMERICA[1]

By GEORGE F. HOWE

Many studies have been made of the variations of individual factors in weather, such as rainfall, temperature, humidity, and others. It is not, however, each factor varying by itself which makes up our weather, but the several factors in their daily combinations. And these combinations are important from many points of view.

Thus, doctors sometimes have occasion to send patients to places with a certain kind of climate, but have no definite information as to where that place may be. An insurance company fortified by a map of weather types would be able to set rates on certain sorts of weather insurance better than a company which "takes a chance." One does not feel as well, nor can he "turn out as much work" on a hot, rainy, quiet day as he can on a moderate, fair, quiet day. Hence, for the purpose of giving a clear picture of the climate of a place, a statement of the frequencies with which well-known types of weather occur is essential.

In the present study, 13 types of weather were chosen from the standpoint of human comfort, and for the five-year period 1917–1921 the percentage frequencies of the occurrence of each type were found for various cities in North America. The 13 types were derived from important combinations of 4 classes of temperature, 2 classes of precipitation (in lieu of humidity and cloudiness, for which daily data were not readily available), and 2 classes of wind. The types and their corresponding symbols are as follows:

Type	Symbol
Hot and rainy	Hr
Hot, fair, and windy	Hfw
Hot, fair, and quiet	Hfq
Moderate and rainy	Mr
Moderate, fair, and windy	Mfw
Moderate, fair, and quiet	Mfq
Cool and rainy	Clr
Cool, fair, and windy	Clfw
Cool, fair, and quiet	Clfq
Cold, fair, and windy	Cdfw
Cold, fair, and quiet	Cdfq
Cold, snowy, and windy	Cdsw
Cold, snowy, and quiet	Cdsq

The criteria upon which the determination of the above types was based were as follows:

Temperature was classified upon the basis of the daily mean: A daily mean over 68° F. was classed as *hot*. A daily mean between 50° F. and 68° F. was classed as *moderate*. A daily mean between 32° F. and 50° F. was classed as *cool*. A daily mean below 32° F. was classed as *cold*.

Windiness.—A day was called windy (in all countries except Canada) if there was a five-minute period with the wind at 25 miles or more an hour, as shown by Weather Bureau anemometers. In Canada the wind velocity is recorded three times a day, at about 8 a. m., 2 p. m., and 8 p. m. (seventy-fifth meridian time) and these velocities are published, while in other countries only maximum wind velocity is recorded. It is likely that the wind was not at the daily maximum velocity at the time of any of the three readings at Canadian stations, so a record of 20 miles per hour at any observation determined a "windy day."

However, owing to differences in exposure of anemometers in different cities, too much weight should not be put upon the wind data.

Rainfall.—As rainfall was chosen to indicate humidity and cloudiness, however roughly, a day was called moist (rainy or snowy) if 0.01 inch or more of rain or (melted) snow fell at any time. Upon examination of the records, it was found that a rainy day was in but very few cases accompanied by a wind of more than 25 miles per hour, so days of this type were not put under a separate head. A wind of 25 miles per hour accompanying snow is a condition decidedly uncomfortable to man.

The period used.—A five-year period was decided upon as the least which could represent the prevailing characteristics of a place. The latest complete five-year period, 1917–1921, was used. These years include some abnormal periods with striking departures from the usual conditions, such as the winter of 1917–18 and the summer of 1918, but the cold periods have compensatory warm ones.

Sources of the data used in this study.—The synthesized data presented in this paper are for summer (June, July, August) and winter (December, January, February). Though data were available for spring and fall, they were not reduced for this preliminary investigation. The daily values of temperature, rainfall, and wind velocity, which have been combined, were kindly furnished by the Government weather services of Canada, the United States, Mexico, Cuba, and the Panama Canal Zone. Only the Canadian, United States, and Panama data were available in published form in the Canadian Meteorological Reports (Ottawa), the Climatological Data for the United States by Sections, and the Monthly Weather Reports, respectively. Since some of the data were missing for Canadian stations and could not be obtained without a great deal of trouble to the Canadian weather service, these were left out. Wind velocity data for the United States were not given in the published reports, and were therefore tabulated at the Weather Bureau office in Washington. The data for Mexico, Cuba, and the Panama Canal were reduced by Dr. J. E. Switzer, who made them available.

Method of procedure.—For each station the data from which were to be used, a separate sheet was prepared showing the three winter months and the three summer months, with the different weather types at the top and the days of the month at the side. The types were then counted by noting their occurrences from the published reports of temperature, wind velocity, and rainfall. The number of occurrences of each type during the month was then found. This process being repeated for each winter month and each summer month for five years for each station, the results were recorded in tables such as the following:

	Phoenix, Ariz.												
	Hr	Hfw	Hfq	Mr	Mfw	Mfq	Clr	Clfw	Clfq	Cdfw	Cdfq	Cdsw	Cdsq
January, 1917				4		9	6		12				
1918				2	1	10	2		16				
1919				2	1	17			11				
1920				2		18	3		8				
1921				2		20	3		6				
Total				12	2	74	14		53				

The totals for the three months were recorded at the bottom of the sheet and the percentage of each weather type was found graphically from these totals. Table 1 was prepared on the basis of this material and the data also transferred to maps, percentages being entered at the locations of the stations. Maps were made also for each factor alone: i. e., the percentage of hot days, fair

[1] Thesis prepared under the direction of C. F. Brooks, and submitted as part of the requirements for the degree of master of arts in geography, Clark University, Worcester, Mass. Presented before the Association of American Geographers and the American Meteorological Society at Cincinnati, Ohio, Dec. 27, 1923. (See Bull. Am. Met'l. Soc. Jan., 1924, vol. 5, pp. 8-10.)

days, windy days, etc., for summer and winter. Examples of the mapping of weather type distribution are presented in Figures 1–3.

In Figure 4 is presented a summary of the weather-type percentages applied to Herbertson's map of the major natural regions of North America.

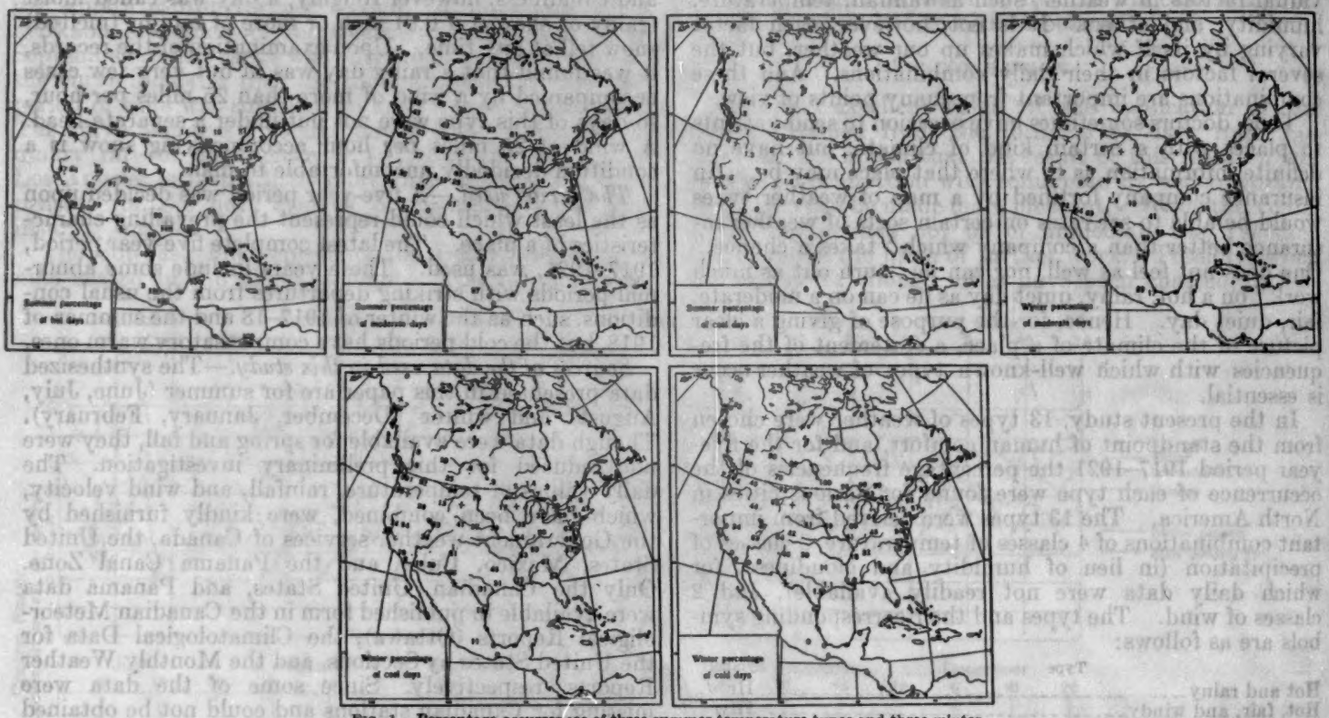


FIG. 1.—Percentage occurrences of three summer temperature types and three winter temperature types, based on mean daily temperature. (See criteria in text)

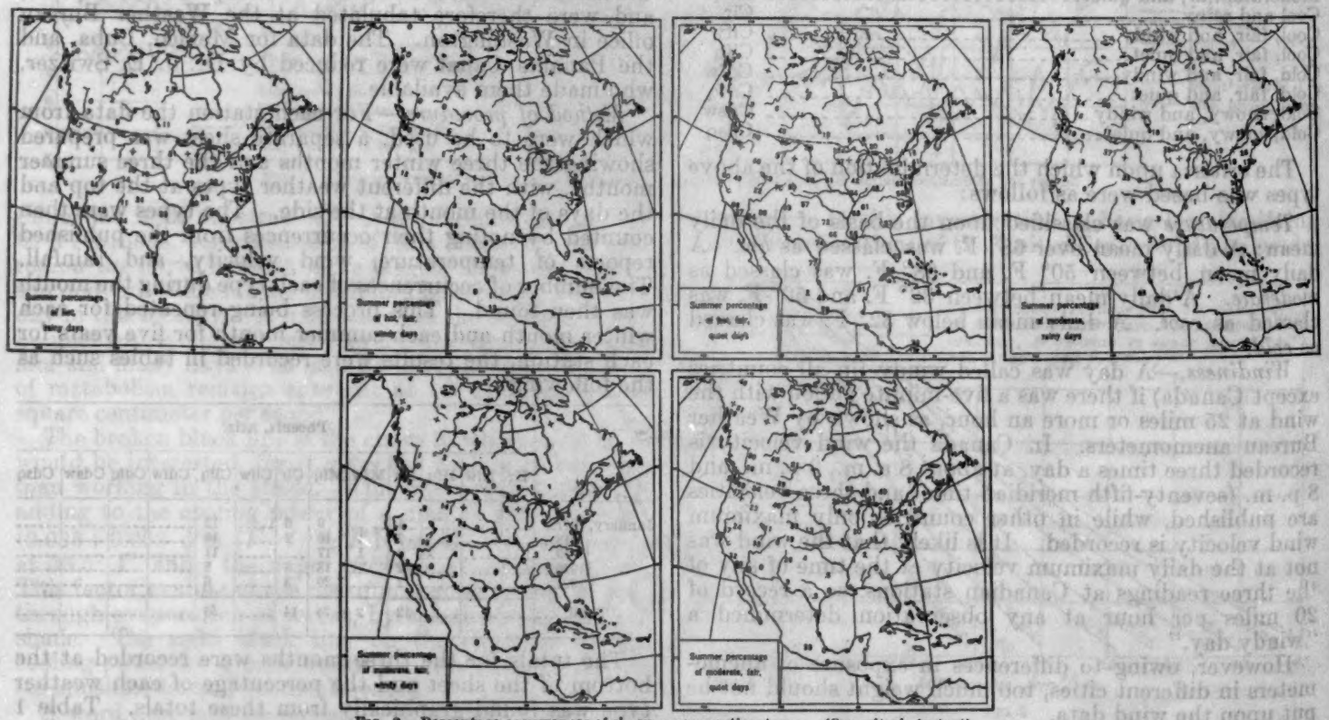


FIG. 2.—Percentage occurrences of six summer weather types. (See criteria in text)

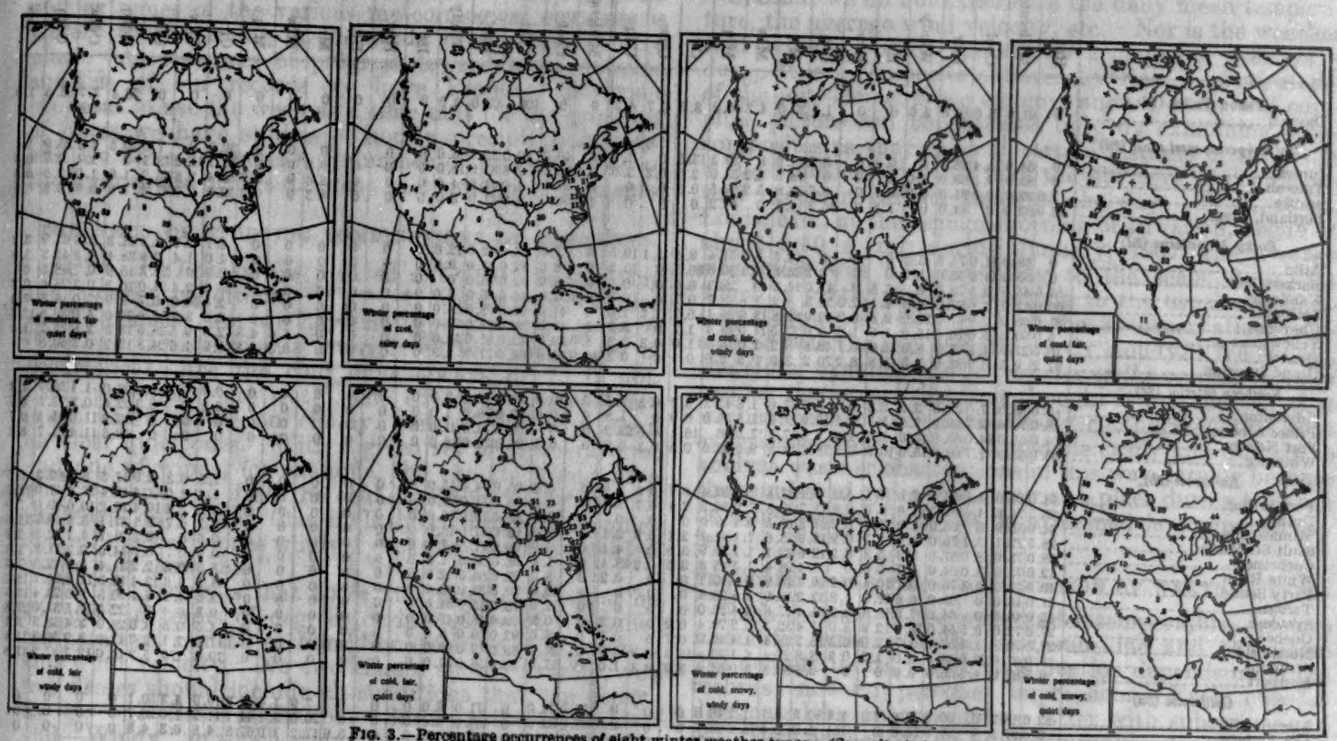


FIG. 3.—Percentage occurrences of eight winter weather types. (See criteria in text)

Summer
1. Hot and rainy
2. Hot, fair and windy
3. Hot, fair and quiet
4. Moderate and rainy
5. Moderate, fair and windy
6. Moderate, fair and quiet
0. Others
Region
2a 3 4 5 6 0
3a 2 3 5 6 0
4a 1 2 3 4 5 6
2d 1 2 3 4 5 6
3d 1 2 3 4 5 6
2c 1 2 3 4 5 6
3c 1 2 3 4 5 6
2b 1 2 3 4 5 6
3b 1 2 3 4 5 6
4b 1 2 3
Winter
1. Moderate, fair and quiet
2. Cool and rainy
3. Cool, fair and windy
4. Cool, fair and quiet
5. Cold, snowy and quiet
6. Cold, fair and windy
7. Cold, fair and quiet
8. Cold, snowy and windy
0. Others
Region
2a 2 3 4 5 6 7 0
3a 1 2 3 4 0
4a 1 2 3 4 7 0
2d 2 3 4 5 6 7 8
3d 1 2 3 4 5 6 7 8
2c 2 3 4 5 6 7 8
3c 1 2 3 4 5 6 7 8 0
2b 2 3 4 5 6 7 8 0
3b 1 2 3 4 5 6 7 8 0
4b 1 0

FIG. 4.—Summary of percentage occurrences of the various weather types, for summer and winter, in Herbertson's Major Natural Regions of North America

TABLE 1.—*Percentage frequencies of weather types for selected stations in North and Central America*

	Summer													Winter															
	Hot	Moderate	Cool	Fair	Windy	Hr	Hfw	Hfq	Mr	Mfw	Mfq	Clr	Clfw	Clfq	Moderate	Cool	Cold	Fair	Windy	Hr	Hfw	Hfq	Mr	Mfw	Mfq	Clr	Clfw	Clfq	Cdsq	Cdfw	Cdfq	Cdsw
Yukon Valley (1d) [1]																																
Dawson	0	91.0	8.0	59.0	5.0	0	0	1.1	39.0	4.3	48.2	3.0	0.7	4.3	0	0	100	69.0	6.0	0	0	0	0	0	0	0	0	0	28.4	3.7	65.5	1.8
Cool temperate west coast (2a)																																
Juneau	0	84.0	15.4	86.0	0	0.3	0	0.3	44.6	0	39.3	13.5	0	1.9	0	40.0	60.0	35.0	3.0	0	0	0	0	0	0	32.8	0	7.0	20.5	2.4	25.9	1.1
Tatoosh	0	95.0	4.5	63.0	8.0	0	0	0	34.5	8.2	53.0	2.0	0.3	2.0	0.3	96.0	2.6	31.0	18.0	0	0	0	0.3	0	0	67.2	16.2	13.1	0	1.4	0.7	0.5
Seattle	7.0	92.0	0.3	81.0	6.0	0.7	0	6.7	18.8	5.9	68.5	0.3	0	0	3	91.0	4.0	41.0	4.0	0	0	0	2.6	0	0	58.4	2.6	35.2	1.0	1.0	2.6	0.5
Portland, Oreg.	35.0	62.0	0	84.0	0	1.8	0	36.3	14.3	0	47.2	0	0	0	4	90.0	6.0	41.0	3.0	0	0	0	4.3	0	0.3	52.0	0.7	37.2	1.8	0.5	2.8	0.5
Rocky Mountains (2d)																																
Atlin	0	69.0	31.0	75.0	5.0	0	0	0	14.5	3.3	51.4	9.5	1.1	19.5	0	7.0	93.0	72.0	12.0	0	0	0	0	0	0	2.7	2.9	1.4	21.3	5.9	61.9	3.2
Barkerville	0	55.0	44.0	45.0	1.1	0	0	0.2	23.8	1.1	30.5	30.3	0	13.5	0	8.0	92.0	53.0	9.0	0	0	0	0	0	0	4.0	1.4	2.9	38.4	4.3	45.2	3.0
Kamloops	54.0	45.0	0.5	75.0	0	6.8	0	47.0	16.3	0	28.3	0.5	0	0	0	8.0	92.0	75.0	0	0	0	0	0	0	0	7.9	0	26.3	16.6	0	48.5	0
Spokane	56.0	43.0	1.0	87.0	4.0	4.1	2.0	50.3	8.2	1.8	33.7	0.7	0	0.3	0.3	52.0	46.0	55.0	4.0	0	0	0	0.3	0	25.6	2.4	24.0	16.3	0.3	28.6	0.3
Cheyenne	31.0	66.0	2.9	67.0	22.0	9.8	8.2	12.9	22.8	13.9	29.1	0.7	1.2	1.0	0	41.0	59.0	78.0	64.0	0	0	0	0	0	0	2.4	30.0	6.7	8.9	27.0	14.3	7.3
Yellowstone	5.0	90.0	5.0	70.0	15.0	1.0	1.0	3.0	27.5	14.0	48.4	1.7	0	3.3	0	13.0	86.0	53.0	20.0	0	0	0	0	0	0	4.6	3.7	5.0	30.0	4.0	39.8	12.3
Denver	70.5	27.7	1.6	77.0	8.0	14.0	6.7	49.8	8.2	1.0	18.5	1.0	0.3	0.3	8.0	50.0	42.0	81.0	14.0	0	0	0	0	0	1.6	4.8	2.6	9.5	38.5	13.5	2.8	25.2	1.0
Grand Junction	91.2	9.5	0.3	83.0	7.0	13.8	6.2	70.2	3.0	0.5	6.0	0	0	0.3	10.0	34.0	64.0	77.0	1.3	0	0	0	0	0.3	0.3	8.9	1.0	24.8	13.2	0.5	50.8	0
Northern interior (2c)																																
Edmonton	8.0	85.0	7.0	57.0	2.0	2.2	0	5.7	37.9	1.8	45.3	3.2	0.3	3.5	0	10.0	90.0	69.0	3.0	0	0	0	0	0	0	0.7	0.5	9.0	28.0	1.1	58.7	1.3
Prince Albert	18.0	79.0	2.7	66.0	2.6	5.7	1.1	10.9	27.0	1.5	51.0	0.9	0	1.8	0	0.6	99.0	76.0	1.0	0	0	0	0	0	0	0.3	0	0.3	22.6	0.3	75.5	0.7
Port Nelson	4.0	51.0	44.0	63.0	13.0	1.5	1.3	1.3	17.3	7.5	26	16.1	4.5	22.2	0	0	100	76.0	21.0	0	0	0	0	0	0	0	0	0	12.9	11.0	65.5	9.7
Winnipeg	35.0	63.0	1.7	60.0	15.0	10.9	5.7	18.0	18.3	9.2	36.0	0.5	0.3	0.9	0	0.3	99.0	73.0	18.0	0	0	0	0	0	0	0	0	0	19.8	11.4	61.7	6.3
Northeast (2b)																																
Port Arthur	14.0	81.0	4.0	68.0	7.0	4.1	1.1	9.1	23.8	5.0	52.4	0.7	0.5	3.0	0	5.0	95.0	74.0	15.0	0	0	0	0	0	0	1.5	0.3	2.9	17.5	8.1	62.3	6.5
Duluth	20.5	74.6	4.5	64.0	11.0	6.0	2.8	11.7	27.8	7.6	39.2	2.4	0.7	1.4	0	4.0	96.0	71.0	39.0	0	0	0	0	0	0	1.4	1.0	1.4	16.4	27.4	41.0	11.2
Minneapolis	64.0	35.9	0	66.0	11.0	21.4	5.2	37.3	11.5	5.4	19.0	0	0	0	0	17.0	83.0	72.0	20.0	0	0	0	0	0	0	3.6	2.4	10.4	15.2	10.6	49.0	7.9
Sault St. Marie	28.5	72.1	5.1	70.0	8.0	7.7	0.9	19.9	23.6	7.1	41.4	2.1	0.9	2.1	0	7.0	93.0	47.0	16.0	0	0	0	0	0	0	3.7	0.7	2.1	37.1	3.5	40.7	11.6
Cochrane	18.0	73.0	8.0	57.0	1.3	5.8	0.2	12.6	32.1	1.1	39.9	3.5	0	4.1	0	0.9	99.0	77.0	7.0	0	0	0	0	0	0	0.6	0	0.3	21.1	4.1	72.8	2.9
White River	12.0	75.0	13.0	64.0	1.7	3.6	0	8.4	28.4	1.5	45 3	3.6	0.2	28.4	0	1.4	98.0	52.0	1.6	0	0	0	0	0	0	0.9	0	0.5	44.5	0.3	51.3	1.3
Parry Sound	40.0	59.0	0.3	70.0	0.2	10.4	0.2	29.6	18.9	0	40.1	0	0	0.2	0	8.0	92.0	56.0	12.0	0	0	0	0	0	0	5.3	0.3	2.2	31.4	4.9	49.5	7.0
Toronto	51.0	48.0	0	65.0	6.6	17.3	1.8	32.2	16.9	4.8	26.4	0	0	0	0	30.0	70.0	53.0	33.0	0	0	0	0	0	0	14.5	3.6	12.4	13.3	11.8	25.7	18.3
Syracuse	53.0	46.0	0	64.0	7.0	18.8	3.0	31.4	17.6	3.4	25.0	0	0	0	0	27.0	73.0	45.0	34.0	0	0	0	0	0	0	13.6	4.1	8.1	20.8	9.5	23.4	19.9
Quebec	27.0	72.0	0.5	54.0	13.2	12.9	3.0	11.4	32.1	10.2	29.4	0.2	0	0.2	0	0.3	99.0	48.0	45.0	0	0	0	0	0	0	0.3	0	0	22.5	17.5	31.0	27.8
Northfield	27.5	70.8	1.4	59.0	1.7	12.0	0.3	15.2	28.4	1.4	41.0	0.7	0	0.7	0	8.0	92.0	60.0	9.0	0	0	0	0	0	0	4.5	0.5	3.0	28.9	3.4	53.3	5.4
St. Johns	10.0	67.0	23.0	58.0	5.0	1.2	0.3	8.3	27.4	4.1	35.4	13.3	0.3	10.3	0	21.0	89.0	49.0	26.0	0	0	0	0	0	0	17.0	2.1	2.0	17.6	8.9	36.3	15.4
Eastport	0.5	87.0	4.5	66.0	3.0	0	0	0.5	30.3	3.0	53.8	3.2	0.3	1.0	0	17.0	83.0	56.0	31.0	0	0	0	0	0	0	10.4	1.0	5.2	16.0	12.7	37.3	17.8
California (3a)																																
Sacramento	82.0	18.7	0	99.0	2.6	0	1.4	80.5	0.7	1.2	16.8	0	0	0	25.0	74.0	0	71.0	6.0	0	0	0	7.9	1.4	15.8	19.9	4.3	50.1	0	0	0	0
San Francisco	2.5	97.5	0	99.0	76.0	0	1.4	1.0	0.5	74.2	23.4	0	0	0	67.0	33.0	0	68.0	3.4	0	0	0	20.0	2.4	44.1	11.2	1.0	20.7	0	0	0	0
Los Angeles	67.5	33.2	0	98.0	0	1.0	0	66.5	0.7	0	32.5	0	0	0	86.0	10.0	0	78.0	1.3	0	0	3.9	17.2	1.0	67.8	4.8	0.3	4.8	0	0	0	0
Cool plateau (3c)																																
Boise	72.4	26.7	1.3	92.0	0.8	4.1	0.3	68.0	3.4	0.5	22.8	0.3	0	1.0	0.8	58.0	44.0	62.0	1.6	0	0	0	0.3	0	0.5	26.7	0.3	30.6	10.0	0.3	30.2	1.0
Reno	63.8	35.9	0.6	94.0	21.0	2.8	12.0	49.0	2.6	9.4	23.9	0.3	0	0.3	0.7	54.0	34.0	78.0	11.0	0	0	0	0	0	0.7	14.4	8.7	41.0	4.3	1.2	27.0	1.2
Salt Lake City	86.0	14.0	0.3	87.0	13.0	10.2	12.2	63.3	2.2	0.7	11.1	0	0	0.3	0	53.0	47.0	68.0	6.0	0	0	0	0	0	0	17.7	2.8	31.6	12.0	1.6	32.5	1.4
Modena	61.0	39.0	0.3	80.0	42.0	13.5	25.4	22.0	6.0	16.3	17.9	0	0	0.3	0	36.0	63.0	81.0	17.0	0	0	0	0	0	0	7.9	6.2	21.6	6.5	7.0	45.9	3.9
Warm plateau (3d)																																
Santa Fe	47.0	51.0	0	67.0	8.0	11.3	2.8	32.6	21.1	4.5	26.3	0.5	0	0	2.4	51.0	46.0	80.0	9.0	0	0	0	1.2	0	1.2	7.2	5.0	38.6	10.1	3.2	31.9	1.2
El Paso	99.0	0.8	0	76.0	20.0	23.6	19.1	56.2	0	0.5	0.3	0	0	0	30.0	65.0	4.0	88.0	27.0	0	0	0	2.0	9.9	17.6	6.7	16.4	43.0	0.7	0	2.4	0.5
Mexico City	2.5	97.5	0	34.5	0	0.5	0	2.0	65.0	0	32.7	0	0	0	89.0	11.0	0	94.0	0	0	0	0	5.0	0	82.6	0	0	0	0	0	0	0
Southwestern desert (4a)																																
San Diego	38.0	62.4	0	98.0	0.3	0.5	0	37.3	1.8	0.3	60.3	0	0	0	92.0	8.0	0	76.0	1.6	0	0	0	20.5	1.6	69.5	2.4	0	5.6	0	0	0	0
Yuma	100.0	0	0	95.0	1.2	5.4	1.2	93.9	0	0	0	0	0	0	84.0	15.0	0	91.0	6.0	0	0	0.5	5.0	4.8	74.4	2.8	1.0	11.0	0	0	0	0
Phoenix	99.7	0.3	0	86.4	1.2	13.3	1.2	85.2	0	0	0	0	0	0	69.0	30.0	0	86.0	1.4	0	0	0.3	8.9	1.4	59.0	5.0	0	25.0	0	0	0	0
Great plains (3c)																																
Medicine Hat	56.0	43.0	1.4	80.0	8.0	5.2	5.7	44.9	11.2	2.3	29.0	0.5	0	0.9	0	25.0	75.0	75.0	7.0	0	0	0	0	0	0	2.6	2.0	20.7	21.1	3.5	48.8	1.1
Havre	56.3	41.8	1.8	74.0	8.0	11.7	5.2	39.4	12.4	3.0	26.4	1.2	0.3	0.3	0	28.0	72.0	75.0	17.0	0	0	0	0	0	0	1.6	10.6	15.5	21.4	5.0	44.0	1.4
Bismarck	59.0	37.0	0.9	77.0	20.0	14.1	12.7	31.9	8.6	7.8	21.4	0.3	0.3	0.3	0	13.0	87.0	77.0	22.0	0	0	0	0	0	0	0.5	3.6	7.7	15.8	13.1	53.1	5.2
North Plate	77.2	21.1	1.7	72.0	1.2	18.0	1.2	58.0	8.2	0	12.9	1.4	0	0.3	0.7	37.0	61.0	83.0	8.0	0	0	0	0	0	0.7	2.2	3.4	31.6	12.1	3.6	44.1	1.6
Omaha	86.7	13.1	0	69.0	1.5	25.1	1.0	60.6	5.9	0.5	6.7	0	0	0	1.3	39.0	59.0	81.0	17.0	0	0	0	0.3	0.3	0.7	4.5	3.9	30.5	7.7	7.5	38.7	5.4
Amarillo	90.0	9.0	0	71.0	10.0	24.5	9.1	56.9	4.8	1.0	3.6	0	0	0	10.0	61.0	30.0	85.0	23.0	0	0	0	0.3	4.8	5.2	6.2	13.1	41.7	8.1	4.1	16.3	1.6
Dallas	99.0	0.8	0	77.0	4.0	22.7	4.5	72.2	0.3	0	0.5	0	0	0	41.0	46.0	11.0	79.0	14.0	0	0.3	1.0	7.9	7.0	26.1	9.9	6.2	30.5	2.2	0.7	7.2	0.5
San Antonio	99.0	0.6	0	80.0	6.0	19.1	6.2	74.2	0.3	0	0.3	0	0	0	59.0	31.0	1.5	77.0	7.0	0	0.5	0.7	12.0	3.9	42.9	8.4	2.4	20.4	0.3	0.5	0.7	0
Humid southeast (3b)																																
Chicago	70.6	29.2	0	61.0	9.0	20.8	7.3	42.5	7.8	1.4	20.0	0	0	0	0.6	38.0	60.0	66.0	22.0	0	0	0	0.3	0.3	0	13.8	7.2	16.6	13.8	8.9	33.4	5.0
Detroit	65.0	34.6	0	69.0	12.0	21.8	6.5	36.7	8.9	5.6	20.1	0	0	0	0	32.0	64.0	62.0	28.0	0	0	0	0	0	0	12.0	4.8	15.1	11.2	12.0	30.3	11.6
Buffalo	51.0	48.0	0	68.0	20.0	13.9	11.9	25.0	18.0	8.4	22.0	0	0	0	0	29.0	71.0	54.0	52.0	0	0	0	0	0	0	15.5	7.5	5.0	11.2	16.3	15.3	28.3
Boston	58.7	40.0	0.3	62.9	4.0	15.2	2.4	41.1	12.7	1.6	25.6	0.3	0	0	0.6	43.0	56.0	62.0	18.0	0	0	0	0.3	0	0.3	19.6	3.9	19.0	11.9	9.5	29.1	5.0
Philadelphia	87.0	12.0	0	66.0	4.0	29.6	2.8	55.0	4.3	1.2	6.7	0	0	0	2.7	60.0	36.0	66.0	16.0	0	0	0	2.2	0	0.5	21.2	8.4	29.7	7.9	6.5	21.7	1.4
New York	73.0	27.0	0	68.0	31.0	22.8	22.8	28.1	9.0	8.2	9.9	0	0	0	0.7	51.0	48.0	64.0	51.0	0	0	0	0.7	0	0	21.4	20.3	8.9	5.0	22.6	12.9	8.4
St. Louis	95.0	4.5	0	71.0	14.0	27.4	13.5	54.1	1.2	0.5	2.8	0	0	0	5.0	54.0	41.0	75.0	29.0	0	0	0	1.2	2.4	1.2	14.0	14.6	25.2	6.0	8.9	23.0	3.2
Cincinnati	81.0	18.0	0	65.0	0.7	31.8	0.7	49.0	3.6	0	14.9	0	0	0	4.0	50.0	45.0	63.0	5.0	0	0	0	2.4	0	1.4	19.3	2.2	27.9	12.9	1.0	30.7	1.8
Baltimore	93.0	6.8	0	66.0	0	31.0	0	62.0	3.4	0	3.4	0	0	0	3.0	63.0	34.0	65.0	1.6	0	0	0	1.4	0	1.8	22.6	0.3	40.3	10.0	0.3	22.6	1.0
Richmond	93.0	7.0	0	63.0	1.5	34.5	1.2	57.8	2.2	0.3	4.1	0	0	0	9.0	66.0	23.0	65.0	10.0	0	0	0	4.5	1.6	3.2	22.2	5.0	39.5	5.9	1.6	14.9	1.0
Memphis	98.0	1.4	0	71.0	2.2	28.3	2.2	68.5	0	0	0	0	0	0	28.0	53.0	18.0	68.0	10.0	0	0.3	0	10.9	2.2	16.3	16.4	2.4	33.9	3.0	2.0	11.9	1.2
Nashville	97.0	3.0	0	67.0	4.0	32.5	3.4	61.0	1.0	0.3	2.0	0	0	0	18.0	59.0	22.0	64.0	13.0	0	0	0	9.1	3.6	5.4	19.5	4.8	34.5	3.0	1.8	14.0	3.0
Raleigh	96.0	4.0	0	63.0	1.0	36.2	0.7	59.1	1.0	0.3	2.8	0	0	0	20.0	63.0	16.0	66.0	10.0	0	0	0	7.7	2.0	10.2	19.9	5.9	37.8	5.2	1.2	9.5	0.3
Atlanta	99.0	0.3	0	59.0	6.0	40.3	5.6	53.5	0.3	0	0	0	0	0	26.0	62.0	10.0	62.0	17.0	0	0	0	0.3	11.6	2.2	12.4	21.4	11.4	29.6	1.6	3.6	3.6	1.2
Savannah	100.0	0	0	58.0	5.0	42.0	5.0	52.8	0	0	0	0	0	0	60.0	34.0	2.6	69.0	15.0	1.0	0.7	1.6	19.4	10.2	30.2	9.4	4.1	20.8	0.3	0.7	1.6	0
Houston	100.0	0	0	69.0	2.6	30.9	2.6	66.5	0	0	0	0	0	0	58.0	31.0	1.1	70.0	6.0	1.8	1.4	6.5	17.6	3.0	37.8	8.4	0.5	21.7	0.5	0	0.3	0.3
New Orleans	100.0	0	0	57.0	0.3	43.0	0.3	56.4	0	0	0	0	0	0	65.0	23.0	1.0	68.0	0.3	3.0	0	7.5	22.1	0	43.1	5.6	0.3	16.9	0	0	1.0	0
Miami	100.0	0	0	55.0	0	44.7	0	55.0	0	0	0	0	0	0	49.0	1.6	0	78.0	3.0	12.7	1.0	37.0	9.1	1.8	37.8	0.3	0.3	1.0	0	0	0	0
Trade-wind region (4b')																																
Habana	100.0	0	0	67.0	10.4	33.0	10.4	55.7	0	0	0	0	0	0	23.0	0	0	80.0	16.0	13.5	10.7	49.7	6.0	5.7	10.9	0	0	0	0	0	0	0
Matamoros	100.0	0	0	78.5	1.5	21.8	1.5	77.0	0	0	0	0	0	0	56.0	13.0	0	88.0	8.0	1.3	4.0	24.8	7.5	1.7	46.8	1.2	0	9.6	0	0	0	0
Vera Cruz	100.0	0	0	46.5	1.0	53.5	1.0	45.3	0	0	0	0	0	0	17.0	0	0	88.0	17.0	10.1	11.2	60.0	2.1	5.6	9.1	2.9	2.7	7.0	0	0	0	0
Progreso	100.0	0	0	81.5	0.3	18.6	0.3	81.0	0	0	0	0	0	0	7.0	0	0	94.0	2.0	5.6	0.3	87.3	0.3	1.0	5.2	0	0	0	0	0	0	0
Salina Cruz	100.0	0	0	72.0	13.3	28.0	13.3	58.4	0	0	0	0	0	0	0.7	0	0	99.0	43.0	1.0	42.9	54.4	0	0	0	0	0	0	0	0	0	0
Cristobal	100.0	0	0	19.4	0.7	80.6	0.7	18.2	0	0	0	0	0	0	0	0	0	46.0	12.0	53.7	12.4	32.9	0	0	0	0	0	0	0	0	0	0
Balboa Heights	100.0	0	0	39.5	0.7	60.7	0.7	38.6	0	0	0	0	0	0	0	0	0	84.0	11.0	16.0	18.8	61.7	0	0	0	0	0	0	0	0	0	0

[1] The number and letter designations correspond to those of A. J. Herbertson's Major Natural Regions, Oxford Wall Maps, 1922, Oxford University Press.

A CLASSIFICATION OF WEATHER TYPES[1]

By E. S. NICHOLS

[Weather Bureau, San Jose, Calif., July 3, 1924]

Consideration of monthly and annual means, totals and extremes of the various meteorological elements is merely the beginning in the study of the climate of a place. As instances of progress toward more detailed analysis of our records we have Professor Marvin's proposal to use the week as a time unit for the grouping of data; we have studies of hourly precipitation data; and we have an increasing number of investigations of the frequencies of the different meteorological elements.

THE NEED OF STUDYING COMBINATIONS OF ELEMENTS

Dr. C. F. Brooks has pointed out[2] that in studying the average conditions, "* * * we have some idea of the climate, but we have not got a correct picture. How are these elements interrelated in their modes of occurrence? Are the cold days always dry? If not, what proportion are wet? The effects of the cold are much more severe on cloudy, wet, windy days than on clear quiet ones. With a given set of temperatures, and one of winds, for example, the climate would be a much severer one if all the cold days were windy and all the warm days quiet, than if all the cold days were quiet and all the warm ones windy. Yet the data as presented would not show this."

He then suggests that 10 or 20 classes of weather be specified in terms of degrees or intensities of sunshine, temperature, rainfall or humidity (relative or absolute), and wind velocity. No two classes should overlap, yet the classes should include all conditions that can occur. E. g., one class might be: "Sunny—Hot—Humid—and—Windy," in which sunny meant less than half the sky covered with clouds; hot, a temperature above a certain figure; humid, a humidity above a certain value; and windy, a wind velocity above a certain speed. Now if there are only two classes of each of these four elements, 16 combinations are possible; and if three classes of temperature are specified there will be 24 classes by the various combinations, with two each of the other three.

More attention given to the combinations of climatological elements, as Doctor Brooks suggests, will undoubtedly produce valuable results. We may consider in the same way not only daily weather, but combinations for other periods as well; thus, we may study the frequencies of months having certain characteristics according to the scale—how many Julys are hot-humid-sunny-windy, how many are cool-dry-sunny-quiet, etc.

In the papers of this group by Howe and Switzer, data for humidity and sunshine are necessarily replaced by those for precipitation, which can, of course, very inadequately fulfill the requirements. For at least two other reasons, moreover, we must go still further if we are to get the most out of a study of weather types:

First, the scales suggested by the above-named writers are of necessity so coarse as to obscure important variations, particularly if they be intended to apply to all climates. Therefore, I have designed a much finer scale of weather types, having 10 temperature divisions, six of relative humidity, 4 of wind, and 3 of sunshine (or cloudiness). This scale provides for 720 different types of weather.

Second, we do not experience the daily mean temperature, the average wind velocity, etc. Nor is the weather that actually occurs constant for a month or even for a day. It is a composite of several variables, particularly of the four elements we employ, and an exact and complete picture can be obtained only by examining these composites as they exist at certain instants of time. It is not sufficient even to take the averages of conditions that occur at certain times of the day. Thus, at St. Louis, Mo., at the regular morning observation, begun at about 6:40 a. m., during January, 1907, the average cloudiness was 6.6 (according to the scale, 0 to 10,) which is partly cloudy according to the usual classification. However, at only 4 of the 31 observations considered was the sky actually partly cloudy. We should, therefore, examine the *frequencies of the various types of weather that occur.* At first thought it may appear that we have undertaken a hopelessly complicated task; but experience shows that it is possible easily and quickly to analyze weather observations in this way, largely because the number of types that occur at a place during a month or other period likely to be examined is comparatively few.

PROPOSED SCALE FOR CLASSIFICATION OF WEATHER TYPES

Each division of the scale under temperature, relative humidity, wind velocity, and sunshine and cloudiness has definite limits; hence classification depends upon the records, not on personal impressions. Each class is designated by an appropriate letter with subscript; and is further defined by an adjective interpreting it according to the writer's experience. Each of the 720 possible types may be conveniently designated by a combination of four adjectives, or of four letters with subscripts, as may be preferred. Thus, $T_0H_{+1}W_0S_2$ indicates "Moderate temperature, humid, quiet, sunny;" or, more definitely, temperature from 60° to 74° F., relative humidity from 75 to 84 per cent, wind velocity less than 10 miles per hour, and clear sky.

TABLE 1. *Scale for classification of weather types*

TEMPERATURE (°F. AND °C.)		
T_{+4}	Scorching	106° (41° C.) and higher.
T_{+3}	Very hot	96° to 105° (35.5° to 40.5° C.).
T_{+2}	Hot	85° to 95° (29.5 to 35.0° C.).
T_{+1}	Warm	75° to 84° (24.0° to 29.0° C.).
T_0	Moderate	60° to 74° (15.5° to 23.5° C.).
T_{-1}	Cool	40° to 59° (4.5° to 15.0° C.).
T_{-2}	Cold	20° to 39° (−6.5° to 4.0° C.).
T_{-3}	Very cold	0° to 19° (−18° to −7° C.).
T_{-4}	Frigid	−20° to −1° (−29° to −18.5° C.).
T_{-5}	Polar	Below −20° (below −29° C.).
RELATIVE HUMIDITY (PERCENTAGES)		
H_{+2}	Damp	85 and above.
H_{+1}	Humid	75 to 84.
H_0	Moderate	50 to 74.
H_{-1}	Dry	30 to 49.
H_{-2}	Very dry	15 to 29.
H_{-3}	Excessively dry	Below 15.
WIND VELOCITY (M. P. H. AND M. P. S.)		
W_3	Storm winds	35 m. p. h. (15.6 m. p. s.) and above.
W_2	Strong	20 to 34 (8.9 to 15.2 m. p. s.).
W_1	Moderate	10 to 19 (4.5 to 8.5 m. p. s.).
W_0	Light	0 to 9 (0 to 4 m. p. s.).
SUNSHINE AND CLOUDINESS		
S_1	Clear	0–3 tenths of sky cloud-covered.
S_1	Partly cloudy	4–7 tenths of sky cloud-covered.
S_0	Cloudy	8–10 tenths of sky cloud-covered.

[1] Presented before the American Meteorological Society at Stanford University, June 26, 1924.

[2] In course on Climatology and Climates of the World, Home Study Department, Clark University.

TABLE 2.—*Frequencies of selected weather types, San Jose, Calif.*

			H-2			H-1			H0			H+1			H+2		
			W0	W1	W2	W0	W1	W2	W0	W1	W2	W0	W1	W2	W0	W1	W2
6.40 a. m. observations January, 1923	T-1	S2													1		
		S1													1		
		S0										1	3		8	1	
	T-2	S2													7		
		S1													3		
		S0													6		
Noon observations January, 1923	T0	S2							1								
		S1															
		S0															
	T-1	S2				1	1		5	1							
		S1							4							1	
		S0							5			9			3		
January, 1923, 4.40 p. m. observations	T-1	S2				1			9	2							
		S1								1		3					
		S0							4	1		7	1		1	1	
April, 1923, 6.40 a. m. observations	T-1	S2										5			5		
		S1							1						3		
		S0							2			5			7	2	
April, 1923, noon observations	T+1	S2				2											
		S1															
		S0															
	T0	S2	1	1		5	1			2							
		S1							1	2							
		S0				1			4	2							
	T-1	S2								1							
		S1															
		S0				1	1		1	1		1		1	1		
April, 1923, 4.40 p. m. observations	T+1	S2		1													
		S1															
		S0															
	T0	S2		1		4			7								
		S1				1											
		S0				1			1	3							
	T-1	S2								1	1						
		S1							1	3			1		1		1
July, 1923, 6.10 a. m. observations	T0	S2										8	1		6		
		S1										1	1		2		
		S0							1			3			6		
	T-1	S1										1					
		S0							1								
July, 1923, noon observations	T+1	S2				1											
		S1	1														
		S0															
	T+1	S2				7	7		2	1							
		S1							1								
		S0															
	T0	S2					1		5	4							
		S1				1											
		S0															
July 1923, 4:40 p. m.	T+2	S2				1	2										
		S1															
		S0															
	T+1	S2					5			4							
		S1															
		S0															
	T0	S2					5		1	12							
		S1								1							
		S0															
October, 1921, 6:40 a. m.	T0	S2															
		S1															
		S0													2		
	T-1	S2										3			5		
		S1													2		
		S0										2			15	1	
	T-2	S2													1		
		S1															
		S0															
October, 1921, noon	T+1	S2	3			2			1			1					
		S1							1								
		S0															
	T0	S2				3			7	1		1					
		S1				1			2	1							
		S0							5								
	T-1	S2															
		S1							1								
		S0							1								
October, 1921, 4:40 p. m.	T+2	S2				1											
		S1															
		S0															
	T+1	S2				2	1										
		S1				1											
		S0															
	T0	S2				3	1		5	4		1	1				
		S1					1		2	1							
		S0							3						1		
	T-1	S2							1	1							
		S1															
		S0										1					
10 very hot days at time of max. temp.: June and July, 1921. June, 1922. July and Sept., 1923.	T+2	S2	3	7													
		S1															
		S0															

In illustration of the use of the scale, in Tables 2 and 3 we have a group of lines for each temperature class and a group of columns for each relative-humidity class. Under each temperature head is a line for each sunshine division; and under each humidity head is a column for each wind-velocity class. In this way we provide a separate space for each of the 720 weather types, or for as many thereof as may be necessary. Suppose we have observed temperature 85°, rel. hum. 35 per cent, wind vel. 8 m. p. h., and clear sky; 85° determines the T_{+2} temperature belt and 35 per cent confines us to the H_{-1} humidity group; and the two conditions place us somewhere in the few types common to belt and group; 8 m. p. h. selects the left-hand column of types and clear sky the upper space, in which we enter a tally mark. Thus we can quickly classify a large number of observations.

In the arrangement used in this case we have emphasized temperature and humidity classes; for all cases in any temperature class appear in a belt extending across the table; and all in a given humidity class appear in a certain group of columns. However, all cases of clear skies occur in the upper lines of the several belts, all cloudy cases in the lowest, and partly cloudy cases in the middle lines. Similarly, classes of light winds are in left-hand columns of groups, while stronger wind cases are placed farther and farther to the right as strength increases. While the prominence of wind and sunshine classes can be made out with little trouble, these divisions could be made more prominent by arranging belts or groups according to wind and sunshine headings. Also, if for any reason we wish to investigate combinations of only two or three meteorological elements, we may omit the unnecessary division or divisions. For instance, temperature and humidity require only a simple set of lines and columns, as we have in Figure 2. Again, we might substitute pressure or some other weather element for any of those we have chosen.

APPLICATION OF THE SCALE TO WEATHER RECORDS

This system is herein first applied to the records of the Weather Bureau office in San Jose, Calif., for the four months, January, April, and July, 1923, and October, 1921. We may gain an excellent idea of the weather throughout the day by studying the conditions that prevail during the warmest hours, the coldest hours, and transition hours. A close approximation to this is provided by the regular thrice-daily observations begun at about 6:40 a. m. (6:10 a. m., from June 1, 1923), local mean noon, and 4:40 p. m. Therefore, in Table 2 have been entered the frequency numbers of the different types of weather observed during the four months considered, each set of observations tabulated separately for each month, making 12 sections in the table, or, rather, 12 separate tables.

For an extended climatic study one should determine percentages of frequencies of various types for each month or other desired periods over a term of years. The months chosen are, however, fairly typical of San Jose's climate, and serve to exemplify the method.

Beginning with January mornings, we note that nearly all the 31 cases fall in the "damp" class; over one-half are "cool," and the remainder are "cold"; nearly all have light winds; about one-half are cloudy; about one-half fall in the two types, "humid-cloudy-light wind-and-cool or cold." "Damp" characterizes nearly all October mornings also, especially numerous being the cool-light wind-cloudy type. April has many of the same types, or of those with the next lower humidity class. July mornings are similar to those of April, but with next higher temperature class, "moderate."

The similar types $T_{-2}H_{+2}W_0S_0$ and $T_{-1}H_{+2}W_0S_0$ are gloomy and might be depressing to some temperaments, especially when foggy or rainy as well; when in the lower temperature class they are chilly, in the other cooling; but the absence of even moderate winds makes them not at all disagreeable. In fact the quiet, damp or humid, cloudy or partly cloudy, cool or cold mornings so numerous at all times of the year are sedative, particularly to a person that has recently come from a very dry, hot, windy climate. The type $T_{-2}H_{+2}W_0S_2$, numerous in morning in January, is frosty weather.

At noon and at night in January the cold types disappear, and cool are almost universal. The very frequent afternoon type $T_{-1}H_0W_0S_2$ is invigorating.

Higher wind and sunshine classes, with lower humidity are more frequent at noon and in afternoon than in morning at all seasons. Particularly worthy of mention is the class $T_0H_0W_1S_2$, which is noted at nearly one-half the late afternoon observations in July, at nearly one-fourth of those observations in April, and at some in October. Outdoor life in this type is agreeable, particularly if physical exertion be moderate only. The types with "moderate" or "dry" as regards humidity and "cool" for temperature favor vigorous physical exertion, whether cloudy or sunny, quiet or moderately windy; these are numerous during the day in January and occur in spring and fall also, rarely in midsummer. Mental activity is favored by cool or moderate temperature accompanied by moderate humidity or humid air, particularly if wind be light and the sky sunny; these types are most typical of San Jose's climate as a whole, including winter days (see January afternoons).

Cases under "dry" are most numerous with moderate or warm temperatures and sunny skies, while the wind is moderate many times, particularly in July. With four exceptions at noon and four in the afternoon in July and two at noon in October, all "warm" or "hot" observations were in "dry" or "very dry" classes. This decrease of relative humidity with temperature increase maintains, to a great extent, the agreeable features of moderate temperatures; because of the increased cooling resulting from more rapid evaporation of perspiration from the skin. This cooling is further increased by increase of wind velocity, as noted above for July. The large classes $T_{+1}H_{-1}$ and $T_{+1}H_0$ are somewhat too warm for the best physical and mental activity; they are most enjoyed sitting in the shade, which is still more emphatically true of cases in "hot" classes, which are infrequent.

Only a few cases fall in the "Very dry" columns. Almost all of these occurred in April and October with sunny skies and moderate or warm temperatures. The only other case falls at noon in July on a "hot" day. Although the cooling effect, on a perspiring skin, is great when the air is very dry, the extreme dryness, especially if long continued and accompanied by strong winds and high temperatures, is injurious. The skin becomes dry and rough; lips crack; a phlegmatic person is stimulated; nervous people become restive and afflicted with insomina. San Jose is, therefore, fortunate in having few cases in these types. During the period examined there were none in "excessively dry" classes, which still more effectively produce the results mentioned above. Such cases do occur at wide intervals.

No case occurred in temperature classes above "hot," among the observations examined. As an additional matter of interest the conditions on 10 "very hot" days, occurring at intervals during the past three years, at times of the maximum temperatures were examined, and will be found at the bottom of Table 2. Relative humidity was determined by interpolating for the dew-point between the noon and evening observations, between which the maximum temperatures always occurred, obtaining the probable depression of the wet-bulb thermometer from dew-point table, and then the relative humidity by the usual method. All 10 cases fell within the two types $T_{+3}H_{-2}S_2$ and W_0 or W_1, 3 and 7, respectively, and illustrate the usual conditions at San Jose during very hot spells. Being short and infrequent and neither excessively dry nor very windy, these spells produce little or no permanent bad effect, although they are uncomfortable during the hottest hours of the day.

TABLE 3.—*Form of table for showing frequencies of 720 selected weather types. Entries in the table are for the means of 4:40 p. m. observations for July during the 3 years 1905–1907, comparing Fresno, Calif., (italic figures) with San Francisco (bold-face figures)*

Temperature	Sunshine	Relative humidity and winds [1]																					
		H_{-3} (Below 15 per cent) excessively dry				H_{-2} (15 to 29 per cent) very dry				H_{-1} (30 to 49 per cent) dry				H_0 (50 to 74 per cent) moderate				H_{+1} (75 to 84 per cent) humid				H_{+2} (85 to 100 per cent) damp			
		W_0	W_1	W_2	W_3	W_0	W_1	W_2	W_3	W_0	W_1	W_2	W_3	W_0	W_1	W_2	W_3	W_0	W_1	W_2	W_3	W_0	W_1	W_2	W_3
T_{+4} (106° and above) scorching	S_2 Clear	*3*	*7*			*2*	*1*																
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_{+3} (96° to 105°) very hot	S_2 Clear	*32*	*12*			*7*	*2*																
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_{+2} (85° to 95°) hot	S_2 Clear	*8*	*5*			*8*	*3*	*1*															
	S_1 Partly cloudy					*1*	*1*																
	S_0 Cloudy		*1*																				
T_{+1} (75° to 84°) warm	S_2 Clear											*1*											
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_0 (60° to 74°) moderate	S_2 Clear										*1*	*2*		*2*	*9*	*7*			*6*				
	S_1 Partly cloudy														*1*				*2*				
	S_0 Cloudy																	*1*	*3*			*1*	
T_{-1} (40° to 59°) cool	S_2 Clear														*2*	*1*			*7*	*5*	*1*	*2*	*1*
	S_1 Partly cloudy																		*3*	*4*			*4*
	S_0 Cloudy																	*1*	*6*	*2*		*1*	*13*	*3*	
T_{-2} (20° to 39°) cold	S_2 Clear																						
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_{-3} (0° to 19°) very cold	S_2 Clear																						
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_{-4} (−20° to −1°) frigid	S_2 Clear																						
	S_1 Partly cloudy																						
	S_0 Cloudy																						
T_{-5} (−21° and below) polar	S_2 Clear																						
	S_1 Partly cloudy																						
	S_0 Cloudy																						

[1] W_0=Light (0-9); W_1=moderate (10-19); W_2=strong (20-34); W_3=stormy (35 and over).

Thus we might continue our inquiry into the climate of San Jose. Gathering the facts from any one section of a table such as I have prepared for that city is very easy.

COMPARISON OF CLIMATES

As suggested above, the recording of weather types for any one station will usually require the use of but a part of the whole range of types in the complete classification Obviously the greater the range of climatic conditions at a given station the larger will be the section of the classification needed.

When we wish to *compare* stations (entries in the table being made with various types and colors of figures corresponding to the stations and months or seasons) it may or may not be necessary to prepare the complete form of table for 720 types. It would be necessary, for instance, in comparing certain low-latitude desert stations with certain high-latitude interior continental stations. It would not be necessary in comparing stations having very similar climates. For instance, if we compare conditions at St. Paul, Minn., at 6:40 a. m. during January, 1907, with those that prevailed at St. Louis, Mo., at the same time, we need five temperature groups (T_0 to T_{-4}, inclusive) and three relative humidity groups (H_0 to H_{+2}, inclusive) only. If, however, we compare afternoon conditions during July at San Francisco, Calif., with those existing at Fresno in the same State at the same time, we require a much larger section of the table; in fact all the humidity classes and the six upper temperature groups are necessary, as is shown in Table III, where I have made such comparison, using data for the three-year period, 1905–1907.

Various possibilities of applying graphic methods to the depicting of weather types based on the classification here proposed, will occur to the reader, though space does not permit of their discussion here.

CONCLUSION

The writer believes that, from a set of weather-type frequency numbers such as those presented here for San Jose (at least if frequency percentages be derived from records for several years) the degree of suitability of a climate for health, pleasure, certain industrial and agricultural operations and many other purposes, can be ascertained to greater advantage than by any other known method; and, further, that some such analysis of the original observations is necessary to an adequate conception of a climate.

WEATHER TYPES IN THE CLIMATES OF MEXICO, THE CANAL ZONE, AND CUBA[1]

By J. ELMER SWITZER, Ph. D.

[Indiana University, Bloomington, Ind., December, 1923]

This study of the frequency of weather types in the climate of certain cities in Mexico, the Canal Zone, and Cuba is an effort to determine the actual weather experienced by the inhabitants of these stations within the Tropics.

As a more systematic attempt is made to develop this part of the world, the problem of adjustment by white man to the conditions of tropical climate will become more and more important. The frequency of unfavorable types of weather at given stations and the frequency of interruptions in the sequence by a more favorable type will become significant in a greater degree, since the development of the vast resources of the Tropics depends upon the ability of progressive peoples to live and work in the climatic conditions found there. Thus it seems that a study of the weather conditions to be encountered from day to day is appropriate.

An effort is made to group the different elements together into the weather types which seem to affect man most and to determine the frequency of each in the climate of the nine stations for which the necessary data were available, and to determine also in some degree the sequences of the various types. The stations are located as follows: Colon and Balboa Heights at the Atlantic and Pacific termini, respectively, of the Canal Zone; Vera Cruz, Progreso, and Matamoros, on the east coast of Mexico; Salina Cruz and Manzanillo, on the west coast; Mexico City, on the plateau; and Habana, Cuba. They range in latitude from about 9° N. to about 26° N. All are near sea-level except Mexico City, which has an elevation of about 7,000 feet above mean sea level.[2]

Certain arbitrary classifications of weather types are made. All days with mean temperatures (generally taken as (max.+min.)/2) over 68° F. are classed as "hot," those with mean temperatures between 50° F. and 68° F. are considered "moderate," while those with mean temperatures between 32° F. and 50° F. are designated as "cool." If the wind during the day reached a maximum velocity of 25 miles per hour for a five-minute period or longer, the day is considered "windy." Days with 0.01 inch or more of rain are called rainy days. By combining these factors, the following nine weather types are adopted: Hot-rainy, hot-fair-and-windy, hot-fair-and-quiet, moderate-rainy, moderate-fair-and-windy, moderate-fair-and-quiet, cool-rainy, cool-fair-and-windy, cool-fair-and-quiet. Three additional types would be used where the mean temperature of the day was below 32° F.; i. e., cold-snowy, cold-fair-and-windy, cold-fair-and-quiet. In the stations considered in this paper the last three types were not feund.

It is recognized at the outset that this classification does not include many items it would be desirable to include, but with the present practices of compiling and recording data, even the above designated information is difficult to obtain.

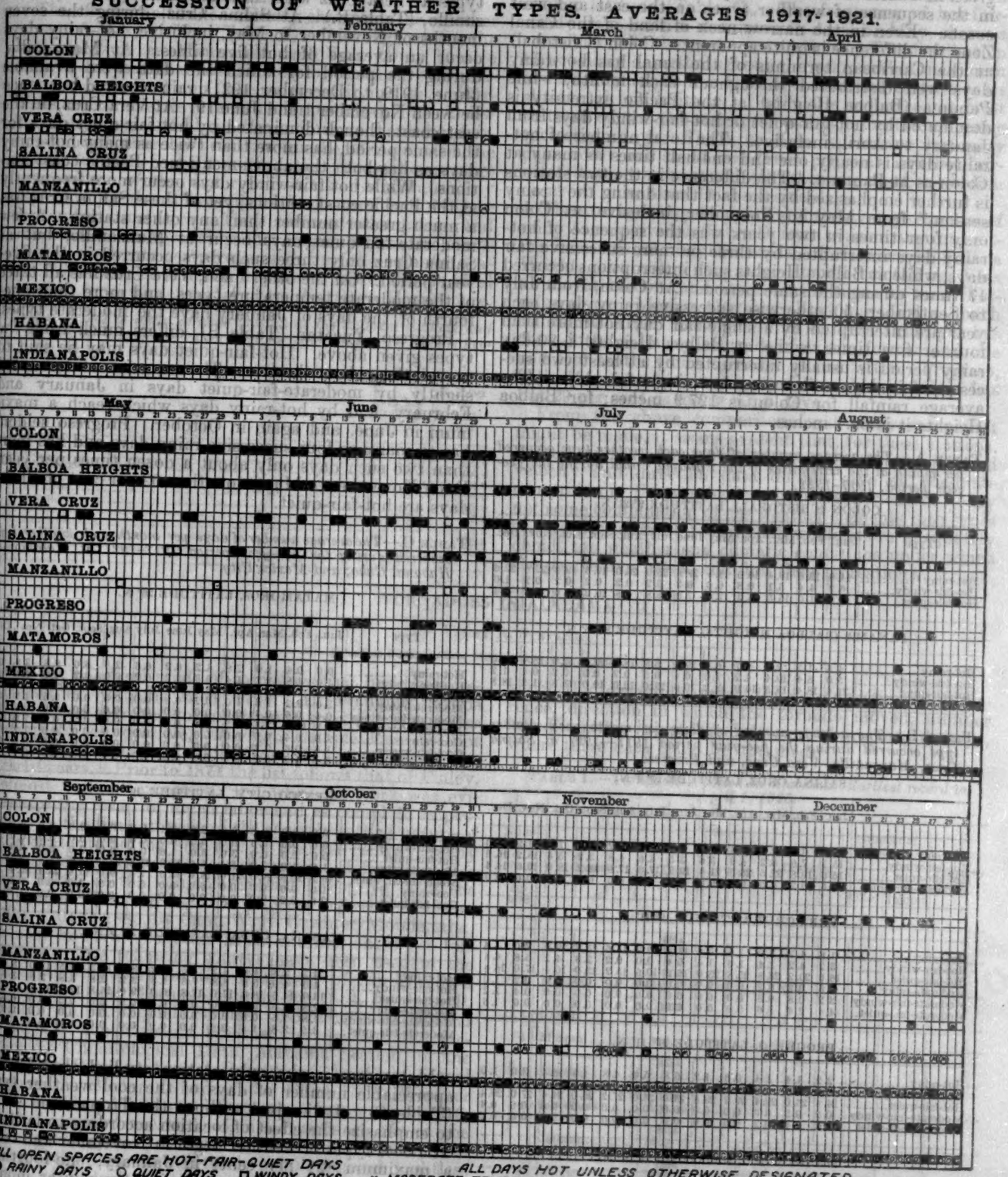
The weather type each day during the five-year period 1917–1921, inclusive, was determined and charted for each of the nine stations[3] in the following way: The temperature of the day was indicated by color; red representing hot days; green, moderate days, and blue, cool days. A windy day was indicated by a square, and a quiet day by a circle. A rainy day was indicated by shading the circle or square, and an open circle or square stood for a fair day. The averages of each type were obtained by counting the whole number of times a type occurred each month for the five-year period and computing the average number of recurrences per year for that month. These were plotted on the accompanying chart as nearly as possible in proportion to their frequency of occurrence, as computed by 10-day periods.

[1] Presented before Association of American Geographers and American Meteorological Society, Cincinnati, Ohio, Dec. 27, 1923. See Bull. Am. Metl. Soc., January, 1924, vol. 5, pp. 9–11.

[2] Grateful acknowledgment is due, for their aid in the pursuit of this study, to the following people: To Maj. Z. Kirkpatrick, chief hydrographer of the Canal Zone; Sr. J. C. Jones, director Meteorologico Central, Tacubaya, Mexico; Sr. José Millás, director Observatorio Nacional, Cuba; and to Mr. P. C. Day, meteorologist in charge, Climatological Division, U. S. Weather Bureau, for the detailed data furnished; Dr. O. L. Fassig, meteorologist of Porto Rico; and J. F. Brennan, of Jamaica, for further data furnished but not incorporated in this paper; Dr. Charles F. Brooks for his helpful suggestions in securing and compiling the data.

[3] The data for Manzanillo are available for only a two-and-a-half-year period, for Habana for four years. Data are lacking for the following other stations: At Vera Cruz for February, 1918; at Salina Cruz for May and June, 1920; at Balboa Heights for April and October, 1918; and for Colon in April, 1917.

SUCCESSION OF WEATHER TYPES. AVERAGES 1917-1921.



ALL OPEN SPACES ARE HOT-FAIR-QUIET DAYS
● RAINY DAYS ○ QUIET DAYS □ WINDY DAYS

ALL DAYS HOT UNLESS OTHERWISE DESIGNATED
m MODERATE TEMPERATURE c COOL TEMPERATURE o COLD TEMPERATURE

The weather types at the low latitude coast stations are given in Tables A and B. They show a marked contrast in the sequence of weather types on the east and west coasts. Even in the narrow neck of land of the Canal Zone the difference is quite apparent. Colon (Cristobal) at the Carribean terminus of the canal has hot-rainy days well distributed throughout each month, while Panama (Balboa Heights) at the Pacific extremity is dominated by hot-fair-quiet or hot-fair-windy days from January to April, inclusive. The total number of hot-rainy days is nearly one and one-half times as many at Colon as at Panama. The difference in the two stations is further emphasized by the fact that during the "rainy season," from May to November, inclusive, at Colon only four times in two years was the sequence of hot-rainy-days interrupted by three or more successive fair days, while at Balboa Heights such interruptions occurred 17 times during the same period. At Colon, from July to September, 50 otherwise successive rainy days each year are interrupted by a single fair day not more than four or five times, while at Balboa Heights a 20-day rainy period is usually interrupted by at least two successive fair days and one or two single fair days. The average rainfall for Colon is 127.9 inches; for Balboa Heights it is 69.4 inches.

TABLE A.—*The average number of days each weather type occurred per month at the extremities of the Panama Canal during the five-year period, 1917–1921*

COLON (CRISTOBAL), LATITUDE 9° 21′ N.

Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hot-rainy [1]	14.0	12.6	10.4	16.0	18.4	22.8	25.0	26.0	19.6	19.2	22.6	22.6
Hot-fair-windy	6.2	4.4	5.1	0.8	0.6	0.2	0.2	0.2	0.2	0.2	0.2	1.0
Hot-fair-quiet	10.8	11.0	15.5	13.2	12.0	7.0	5.8	4.8	10.2	11.6	7.2	7.4

PANAMA (BALBOA HEIGHTS), LATITUDE 8° 56′ N.

Hot-rainy	4.6	1.2	2.1	9.7	16.8	19.0	6.8	18.8	20.0	17.0	18.4	11.0
Hot-fair-windy	5.0	8.4	10.4	4.2	1.0	0.4	0.6	0.2	0.0	0.2	0.4	1.2
Hot-fair-quiet	21.4	18.4	18.5	16.0	13.2	10.6	23.6	12.0	10.0	13.8	11.2	18.8

TABLE B.—*The average number of days per month each weather type occurred during the five-year period 1917—1921 at Salina Cruz, Manzanillo, Vera Cruz, and Progreso.*

SALINA CRUZ, LATITUDE 16° 9′ N.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hot-rainy	0.2	0.4	0.2	0.4	2.8	7.2	8.6	9.2	8.6	7.4	1.2	0.0
Hot-fair-windy	15.2	7.6	8.2	4.6	5.6	3.5	4.6	4.8	3.2	5.6	18.2	16.6
Hot-fair-quiet	15.0	19.8	22.6	25.0	21.6	19.3	17.8	17.0	18.2	18.0	10.6	14.4
Moderate-fair-quiet	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VERA CRUZ, LATITUDE 19° 11′ N.

Hot-rainy	1.8	1.7	3.0	1.8	6.6	13.4	20.2	15.6	15.2	9.9	7.0	4.4
Hot-fair-windy	3.2	4.2	1.4	1.6	1.4	0.4	0.0	0.2	2.8	4.2	5.8	6.4
Hot-fair-quiet	16.6	20.2	23.8	25.8	23.0	16.2	10.6	15.2	15.0	16.4	17.0	16.4
Moderate-rainy	0.6	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0
Moderate-fair-windy	3.2	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2
Moderate-fair-quiet	4.4	2.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6

PROGRESO, LATITUDE 21° 11′ N.

Hot-rainy	2.2	1.4	1.4	0.6	1.2	6.8	5.0	4.8	4.8	6.4	3.0	1.0
Hot-fair-windy	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.2	0.2	0.0	0.0
Hot-fair-quiet	24.4	26.0	29.4	29.2	29.8	23.0	26.0	27.2	26.0	24.4	27.0	29.4
Moderate-fair-windy	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Moderate-fair-quiet	4.2	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2

MANZANILLO, LATITUDE 19° 0′ N.

Hot-rainy	0.0	0.0	0.0	0.0	0.0	3.0	8.6	6.6	9.0	3.0	1.0	0.0
Hot-fair-windy	3.0	0.5	3.0	2.0	2.0	1.0	1.2	1.0	2.0	2.0	1.0	0.0
Hot-fair-quiet	28.0	25.5	25.0	20.0	29.0	25.4	21.2	23.4	19.0	27.0	28.0	31.0
Moderate-fair-quiet	0.0	2.0	3.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1] More rainy days were also windy than there were hot-windy-days.

The difference in the weather of the two coasts is further illustrated by a comparison of the sequence of types at Vera Cruz with those at Salina Cruz and Manzanillo, (Table B.) At Salina Cruz, during the seven months of November to May, inclusive, hot-rainy days occur an average of but five times. At Manzanillo, during the period for which the data were available (June, 1919, to December, 1921), rain occurred but once between November 1 and June 19. At Vera Cruz, on the east coast, though dominated by hot-fair-quiet days for the same period, has more than twice as many hot-rainy days as has both the above-mentioned Pacific coast stations. While hot-fair-windy days occur more frequently at the Pacific coast stations, yet of these Salina Cruz has a much greater number than any other station. A few moderate-fair-quiet days occur at Manzanillo, but at Salina Cruz only three such days occurred in the five-year period. On the other hand, Vera Cruz has all three of the moderate temperature types, and more than one-fourth of the days of January have the moderate types.

Progreso, Yucatan (Table B), differs much from the types given above. Hot-fair-quiet days may be said to prevail throughout the year. The sequence is interrupted slightly by moderate-fair-quiet days in January and February, and by hot-rainy days which reach a maximum in June, and again in October. Progreso seldom has as many as four successive rainy days and has more than two such days only about a dozen times per year. From November to May, more than 92 per cent of all the days are hot-fair-quiet.

TABLE C.—*The average number of days per month each weather type occurred during the five-year period 1917–1921 at Matamoros; Habana, Cuba; and Mexico City*

MATAMOROS, LATITUDE 26° N.

Type	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hot-rainy	0.0	0.4	1.0	2.8	4.2	6.2	6.6	2.8	6.6	6.8	3.8	0.8
Hot-fair-windy	1.0	1.8	1.2	1.4	0.8	1.2	0.2	0.0	0.2	0.2	1.6	0.8
Hot-fair-quiet	6.0	7.0	18.4	20.8	25.4	22.6	24.3	28.2	23.0	22.8	13.8	10.0
Moderate-rainy	3.0	2.2	1.6	1.0	0.2	0.0	0.0	0.0	0.0	0.6	1.6	2.2
Moderate-fair-windy	0.6	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
Moderate-fair-quiet	13.8	14.0	7.4	2.2	0.4	0.0	0.0	0.0	0.2	0.8	7.0	13.6
Cool-rainy	1.6	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.8
Cool-fair-windy	1.6	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4
Cool-fair-quiet	3.4	1.2	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.6

MEXICO CITY, LATITUDE 19° 26′

Hot-rainy	0.0	0.0	0.0	0.6	2.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Hot-fair-windy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hot-fair-quiet	0.0	0.0	0.0	3.0	5.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Moderate-rainy	1.2	1.0	2.0	5.4	5.4	15.0	23.4	22.0	15.6	7.6	2.4	1.4
Moderate-fair-quiet	26.2	25.8	29.0	21.0	18.4	13.0	7.6	9.0	14.4	23.4	25.4	23.4
Cool-rainy	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2
Cool-fair-quiet	2.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	6.0

HABANA, CUBA, LATITUDE 23° 9′ N.

Hot-rainy	3.2	2.8	4.8	4.2	5.5	9.2	8.5	11.5	14.5	11.0	8.0	7.0
Hot-fair-windy	4.0	4.0	5.8	8.8	7.8	4.8	3.2	2.8	3.8	2.8	3.5	3.5
Hot-fair-quiet	16.0	14.5	18.0	17.0	17.8	16.0	19.0	16.8	12.2	17.8	18.0	16.0
Moderate-rainy	2.5	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
Moderate-fair-windy	1.8	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Moderate-fair-quiet	3.5	3.8	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5

Matamoros is the only station studied that has an appreciable number of days of the cool weather types (Table C). It lies just without the Tropics and serves to emphasize the effect of location according to latitude. The cool types of weather begin in November and reach a maximum (21 per cent) in January, one-fourth of which are cool-rainy days. During the winter months about one-half the days are moderate-fair-quiet, one fourth are hot-fair-quiet, the remainder are divided among the other seven types and give great variety to the

weather. The "rainy season," from June to October, has hot-rainy days about one-third the time and hot-fair-quiet days the remainder.

The effect of altitude is clearly shown by the weather types of Mexico City (Table C). Although about the same latitude as Manzanillo and Vera Cruz, Mexico City is dominated almost entirely by the moderate temperature types. From October to April, inclusive, four-fifths of all the days are moderate-fair-quiet. A few hot-rainy days and about three times as many hot-fair-quiet days occur between the middle of April and the middle of June. At no other time does the average temperature of the day reach 68° F. Moderate-rainy days occupy about two-thirds of the time from May to September, inclusive. The increased cloudiness and evaporation are probably the largest factors in maintaining moderate temperatures during the summer season. Mexico City would appear to have almost ideal weather for a winter resort of the Northern Hemisphere.

TABLE D.—*The mean annual rainfall at the different stations and the average number of rainy days for each station during the five-year period 1917–1920*

Station	Inches rainfall	Number of rainy days
Colon	127.9	229.0
Balboa Heights (Panama)	69.4	154.4
Vera Cruz	68.0	90.0
Salina Cruz	39.4	46.0
Manzanillo	26.0	32.0
Progreso	17.2	37.4
Matamoros	36.6	58.6
Mexico City	23.1	126.8
Habana, Cuba	51.7	80.0

Habana serves to compare the weather types of an insular location with those of continental stations of similar latitude (Table C). The frequency of hot-fair-windy days, with a maximum in April or May, shows a resemblance to the west-coast stations. The distribution of hot-rainy days throughout the year, with a maximum in late summer, is like that of a modified eastern coast climate of low latitude. Unlike the sequences at most stations on the continent, no one type occurs on many successive days. Three or four successive hot-rainy days occur but about five times per year, and hot-fair-quiet days, which exceed all others in number, seldom occur on more than 10 successive days.

The average annual rainfall and the average number of rainy days is given in Table D, from which many interesting comparisons may be made. For example, Balboa Heights has about the same annual rainfall as Vera Cruz, yet has one and seven-tenths times as many hot-rainy days. Mexico City has about one-third as much rainfall as either Balboa Heights or Vera Cruz, yet has three-fifths as many rainy days as the former and one and four-tenths times as many as the latter. Progreso, with 75 per cent as much rainfall as Mexico City, has but 29 per cent as many rainy days.

From the above comparisons and many more that might be made, it seems evident that, for these stations, annual and seasonal rainfall, temperature, and wind velocity and direction data do not give an adequate conception of the weather conditions experienced. May not some combination of the weather elements into types of weather units be found that would more adequately depict the weather and climatic conditions under which the people live, work, and find their recreation?

TORNADOES IN ALABAMA

By WELBY R. STEVENS

[Weather Bureau Office, Montgomery, Ala., April 25, 1925]

A list has been made of tornadoes that have been reported in Alabama since 1794. All available records have been searched in an attempt to make this list as complete as possible, although completeness is not claimed, due to lack of information, especially in the early years. Prior to 1871 the list follows that of Finley, almost without exception, and while his work was evidently the result of much labor and as complete as possible at the time, in view of the sparsely settled nature of the State up to the first half of the last century, many tornadoes must have escaped notice. Advantage was also taken of the valuable Special Paper No. 1 of the Alabama Weather Service: Record of the Weather from 1701 to 1885, by Capt. W. H. Gardner, Mobile, Ala., which, however, contains little information about tornadoes. The following sources have been used in the tabulation: Report on the Character of Six Hundred Tornadoes, and Tornado Studies for 1884, by John P. Finley, U. S. Signal Service, Bulletins and Special Papers of the Alabama Weather Service, and the succeeding Climatological Data, Alabama Section, of the Weather Bureau, Annual Reports of the Chief Signal Officer, U. S. Army, and of the Chief U. S. Weather Bureau, THE MONTHLY WEATHER REVIEW since 1876, and correspondence and original records on file at the Montgomery, Ala., Weather Bureau Office. Many sections of the State are still thinly populated, and doubtless many tornadoes in recent years have occurred without coming to notice, but certainly the most severe ones since the establishment of the Signal Service in 1871 appear. The list, Table No. 1, shows the county in which the tornado occurred, the date and time of occurrence, direction in which the tornado moved, number killed, number injured, and amount of property damage, where these data could be obtained.

TABLE 1.—*Tornadoes reported in Alabama: Earliest record to April 1, 1925.*

Number on chart in figures	County	Date	Time	Direction of path	Number of persons—		Property loss
					Killed	Injured	
		1794					
1		Aug. —					
		1822					
2	Morgan	Apr. 16	5 p	NE			
		1823					
3	Chilton			E. 10° N.			
4	Morgan	Apr. 6	9 p	NE			
		1824					
5	Pickens						
		1829					
6	Tuscaloosa	Apr. 25					
		1830					
7	Calhoun	May 1					
		1834					
8	Morgan	June 16	4.30 p	NE			
		1840					
9	Blount			E. 20° N.			
10	Etowah			E. 20° N.			
11	Blount	Mar. 10	6 p	E.			
12	Jefferson	Mar. 16	do	NE			
13	Mobile	Mar. 24	7 p	S. 80° E.			

TABLE 1.—*Tornadoes reported in Alabama: Earliest record to April 1, 1925*—Continued

Number on chart in figures	County	Date	Time	Direction of path	Number of persons— Killed	Number of persons— Injured	Property loss
		1842					
14	Tuscaloosa	Mar. 4	6 a.	NE.			
		1843					
15	Tuscaloosa			E. 45° N.			
		1854					
16	Lee	Mar. 7	1 p.	NE.			
		1855					
17	Pickens	Mar. 12		SE.			
		1857					
18	Cherokee	May 24		NE.			
		1858					
19	Lee			NE.			
		1861					
20	Cleburne	Nov. 30	10 p.	NE.			
		1863					
21	Cleburne	Mar. 4	11 p.	NE.			
		1864					
22	Lee	Dec. 25	Midnight.	NE.			
		1866					
23	Cherokee			E. 40° N.			
24	Cleburne	Apr. 16	11 p.	NE.			
25	Talladega	May 6	8 p.	E. 10° N.			
		1867					
26	Calhoun	Feb. 15		E. 10° N.			
27	Tuscaloosa	Apr. 29	10 a.	E. 20° N.			
28	Cleburne	May 4	Midnight.	NE.			
29	Cleburne	May 26	8 p.	E. NE.			
		1868					
30	Cleburne	Feb. 12	3 p.	NE.			
31	Pickens and Tuscaloosa.	May 8					
		1869					
32	Clay	Jan. 29	8.30 a.	E.			
33	Talladega	Apr. —		NE.			
34	Pickens	May 6	6 p.	E.			
		1870					
35	Calhoun	Jan. —	8 a.				
36	Marshall	Apr. 23		NE.			
37	Calhoun	Dec. 24					
		1871					
38	Coosa and Tallapoosa.	May 1	10 a.	E.			
		1873					
39	Cleburne	Nov. 16	Midnight.	NE.			
		1874					
40	Jackson and Calhoun.						
41	Hale	Nov. 22	Afternoon.	SE.			
42	Colbert	do	6 p.	NE.	12	30	$100,000
43	Shelby	do	Midnight.	E. 10° S.			
44	Dallas	Nov. 27					
		1875					
45	Cherokee			E. 30° N.			
46	Lamar	Feb. 24	6.30 p.	NE.			
47	Lee and Chambers	Mar. 20	2 p.	NE.			
48	Pike	do					
		1876					
49	DeKalb	Apr. 23		NNE.			
50	Etowah	Dec. 25		E. 20° N.			
		1878					
51	Hale	Mar. 27					
52	do	Apr. 23	5 p.	NE.			
		1879					
53	Chilton	Feb. —					
		1880					
54	do	Feb. 13		ENE.			
55	Barbour	Mar. 15	Evening.				
56	Pike	Mar. 18	do	NE.			
57	Jackson	Apr. 25	Afternoon.	NE.			
58	Blount	Dec. —		SE.			
		1881					
59	Cherokee			ENE.			
60	Tuscaloosa	Feb. 18	Afternoon.	NE.			
61	Perry	Feb. 26	Midnight.	NE.			
62	Randolph	Mar. 22	1 a.	NE.			
63	Sumter	Mar. 23	5 p.	NE.			
		1882					
64	Madison	Feb. 28	11.45 a.	NE.			
65	Washington	Mar. 27	2.30 p.	E.			
66	Dallas	Mar. 27	Night.				
67	Lee	do	2.30 p.				
68	Barbour	do	Night.				
69	Henry	do	9.30 p.	E.			
70	Etowah	Apr. 2		NE.			
71	Choctaw	Apr. 22	4 p.	NE.			
		1883					
72	Jefferson	Jan. 16		NE.			
73	Blount	Apr. 2		SE.			
74	Talladega	Apr. 22			1		
75	Jefferson			NE.			
76	Cherokee	Apr. 22	10.30 p.				
77	do	Apr. 23	4.30 p.	NE.			
		1884					
78	Fayette	Jan. 11	6 p.	E.			
79	Pickens	Feb. 19	11 a.	NE.			
80	do	do	Noon	NE.			
81	Jefferson and St. Clair.	do	1.20 p.	NE.	11	31	$80,000
82	Talladega and Calhoun.	do	2 p.	NE.	16	50	
83	Marshall	do	9 p.				
84	Cherokee	Mar. 6	4 p.				
85	Pickens	Mar. 11	7 p.	NE.			
86	Marshall	do	7.30 p.				
87	Greene	do	8 p.	NE.			
88	Tuscaloosa	do	10.30 p.	NE.			
89	Barbour	Mar. 24	2 a.	NE.	1	(1)	
90	Jefferson	Mar. 25	2 p.	NE.			
91	Cherokee	do	8 p.	NE.		1	
92	Chambers	do	— p.				
93	Lawrence and Jackson.	Apr. 1	6 p.	NE.			
94	St. Clair	do	Midnight.	NE.	1		
95	Blount and DeKalb.	do		NE.			
96	Blount	Apr. 2	Night.	NE.	7		
97	Madison	do	do		3	4	
98	Lawrence	Apr. 12	2.30 p.				
99	Franklin and Colbert.	Apr. 14		NE.			
100	Cullman	Apr. 15					
101	Henry	do	— a.				
102	Lee	do	Midnight.	NE.			
103	Morgan	do	Dusk			2	
104	Perry	do					
104a	Elmore	Apr. 19		NE.			
104b	Cherokee	Apr. 25	9 p.	NE.			
105	Morgan	July 5	6 p.	SE.			
106	Lee	Dec. 12	Night.	NE.			
		1885					
107	Randolph	Jan. 11					
108	Macon	do	11 p.	E. 20° N.	1		
109	Coosa and Clay	do	9 p.	E. 10° N.			
110	Lamar, Fayette and Walker.	do	5 p.	E. 15° N.	1	(1)	
111	Greene, Hale, Bibb and Chilton.	do	6.20 p.	E. 30° N.			
112	Cullman, Blount, Marshall, and DeKalb.	do	7 p.	E. 20° N.	1	(1)	
113	Coosa	Feb. 20	5.30 p.	NE.			
114	Marshall	Mar. 28	Afternoon.				
115	Dallas	Apr. 30	5.30 p.	SE.			
116	Madison	May 6	6.30 p.	N. 45° E.			
117	Autauga, Chilton and Bibb.	do	4.30 p.	N.			10,000
118	Morgan	Nov. 6	11 a.	NE.			10,000
119	Sumter	do	8 p.	NE.			
120	Lamar	do	10 p.	NE.			
121	Dallas	do	2 p.	NE.	5	41	
		1886					
122	Clarke	Mar. 27		E.			
123	Lee	Mar. 29		NE.		(1)	
124	Elmore	do	Morn.	NE.			
125	Bullock	Mar. 30	11-12 a.	NNE.		7	
126	Hale	Apr. 25	Afternoon.	NE.			
		1887					
127	Washington	Jan. 18	Morn.	NE.			
128	Jefferson	Apr. 18	3 a.	NE.			
129	Lamar	Apr. 22	6 p.	NE.			
		1888					
130	Pike	June 26	Afternoon.	E.			
131	Talladega	do	do	E.			
		1889					
132	Bibb	Feb. 18	2 a.	NE.	(1)	(2)	
		1890					
133	Geneva	Feb. 7		N. 20° E.			

[1] Several.

[2] Many.

TABLE 1.—*Tornadoes reported in Alabama: Earliest record to April 1, 1925*—Continued

Number on chart in figures	County	Date	Time	Direction of path	Number of persons— Killed	Number of persons— Injured	Property loss
		1890					
134	Pickens	Feb. 27	7.30 p.	NE.	1	3	
135	Pickens	do		NE.			
136	Talladega	do	Night	NE.		(1)	
		1891					
137	Tuscaloosa	Feb. 9	3 p.			(2)	$2,000
138	Shelby	do	3.30 p.	NE.			5,000
		1892					
139	Chambers and Randolph.	Jan. 5		NE.	(3)	(3)	
140	Monroe	Nov. 7	Morn.	NE.			
		1893					
141	Sumter	Mar. 3	6.30 p.		1		
142	Choctaw	do	7.30 p.	E. 10° S.			Slight.
143	Choctaw	Apr. 19	8 p.	NE.		(1)	2,000
144	Dale	do	11 p.	NE.		1	25,000
		1894					
145	Jefferson	Feb. 3		E.	4	26	50,000
146	Wilcox	Feb. 12	4 a.	NE.	1		1,500
		1895					
147	Mobile	Jan. 15 or 16	8.30 p.	NE.			20,000
148	Escambia	Mar. 7		NE.			
149	Pike	Mar. 13	10 a.				100
150	Barbour	do	do	NE.			13,000
151	Baldwin	July 21			(4)		
		1896					
152	Marshall	June 9	11 a.	E.		5	5,000
		1897					
153	Lowndes	Aug. 2		NE.			2,500
		1898					
154	Jefferson	Jan. 19–20	Night				
		1899					
155	Walker	Mar. 15	1 a.	NE.			1,500
156	Jefferson	do	4.55 a.	NE.		1	25,000
157	Montgomery	Mar. 18	1.10 p.	NE.		(1)	10,000
158	Cleburne	do	5.30 p.		11	14	2,500
159	Shelby	do	7.30 p.		3		1,000
160	Montgomery	Mar. 28	10 a.				
161	Jackson	May 29	11 a.	NE.			
		1900					
162	Greene	June 24	6.45 a.	NE.			5,000
163	Jefferson	do	11 a.	NE.			500
164	Cullman	do	3 p.	N.		1	1,500
165	Marion	Nov. 20	6–6.10 p.	NE.		1	550
166	Madison	Nov. 21	2.30 a.	NE.			4,500
167	Mobile	Dec. 23	2 a.	NE.			3,000
168	Butler	do	2.30 a.	NE.			
		1901					
169	Jefferson	Mar. 25	9.40 a.	NE.	11	40	170,000
170	Pickens	Apr. 17	9 p.	NE.			5,000
		1902					
171	Greene	Mar. 15–16	Night	NE.	1	12	
172	Bibb	do	do	NE.	1	(1)	3,000
		1903					
173	Cullman	Apr. 8	1.30 a.	NE.	12	10	45,000
174	Bibb	Apr. 13	6–8 a.	NE.			35,000
175	Conecuh	do	do	SE.	3	(1)	3,000
176	Shelby	Nov. 11	4 p.	NE.			
		1904					
177	Hale and Tuscaloosa.	Jan. 22	12.20 a.	NE.	36	80	92,000
178	Mobile	May 30	4 p.	NE.			200
		1905					
179	Chambers and Randolph.	Mar. 20	3.20 p.	NE.	9	19	5,000
		1906					
180	Pike	Jan. 3	11.30 a.	NE.	2		1,000
		1908					
181	Walker, Jefferson, Blount, Marshall, and DeKalb.	Apr. 24	2.40–4.15 p.	NE.	35	188	650,000
182	Lowndes and Montgomery.	Apr. 24	9 p.	NE.	2	22	83,000
183	Pike	Apr. 30	1.30 a.	NE.		10	35,00

[1] Several.
[2] Many.
[3] A number.
[4] Very destructive to life and property.
[5] A waterspout went ashore.

TABLE 1.—*Tornadoes reported in Alabama: Earliest record to April 1, 1925*—Continued

Number on chart in figures	County	Date	Time	Direction of path	Number of persons— Killed	Number of persons— Injured	Property loss
		1909					
184	Cullman	Feb. 5	1.15 p.	NE.	1	12	$5,000
185	Lowndes and Montgomery.	do	4.40 p.	NE.	3	17	7,800
186	Colbert	Feb. 23	5.30 p.	NE.	1	1	5,000
187	Calhoun	Apr. 13	3 a.	NE.			1,000
188	Lawrence and Morgan.	Apr. 30	Noon	E.	1	18	18,000
189	Calhoun	do	4.30–5 p.	NE.			1,000
190	Clay	do	8 p.	NE.		7	1,000
191	Escambia	May 5	3 a.	NE.			2,000
192	Madison and Morgan.	May 30	5 p.	NE.			(6)
		1910					
193	Monroe and Butler.	Apr. 16	9 a.	NE.		(1)	10,000
194	Macon	Apr. 26					
195	Macon	Apr. 27	4 p.				
		1911					
196	Monroe	Mar. 26	4.45–5.30 p.	NE.	2	50	25,000
		1912					
197	Henry	Mar. 14	11.30 p.				
198	Geneva, Houston, and Henry.	Mar. 15	3 a.	NE.	9	50	50,000
199	Butler	Apr. 17	3.45 a.	E.			
200	Pike	do	4 a.	E.		2	3,500
201	Jefferson	Apr. 22	4.30 a.	E.	1	18	30,000
202	Talladega	May 11	8 p.				75,000
		1913					
203	Butler, Crenshaw, and Pike.	Feb. 27	—a.			3 or 4	100,000
204	Macon	Mar. 13	12–1 a.	NE.		5	3,000
205	Talladega	do	3.20 p.	NE.			4,000
206	Calhoun	do	3.25 p.			(1)	
207	Talladega	do	4 p.	E.		2	1,000
208	Etowah and Cherokee.	do	8 p.	NE.		1	2,000
209	Bullock	Mar. 14		NE.			
210	Russell	do	3.30 a.				
211	Lauderdale	Mar. 20	Night		3		25,000
212	Morgan	do	5 p.		1		
213	Talladega	Mar. 21	a.	NE.			25,000
214	Talladega	do	a.	NE.			
215	Morgan	do	2 a.		3		11,000
216	DeKalb	Mar. 26	2.30 p.	NE.		2	100
217	Macon	Mar. 29	10 p.	NE.		2	1,000
		1914					
218	DeKalb	Apr. 7					5,000
		1915					
219	Choctaw	Dec. 17					
220	Montgomery	do					
		1916					
221	Montgomery	Feb. 28	10.30 p.			1	
222	Mobile	Apr. 20	4.40 p.	NE.	1		3,500
223	Jefferson	May. 22	12.47 a.	NE.	3	1	15,000
224	Jefferson	June 6	11 a.	E.		(2)	5,000
225	Tallapoosa	July. 6	4–5 p.	N.		1	
226	Montgomery	Oct. 18	2.30–3 p.				2,000
		1917					
227	Hale	Feb. 23	1 p.	NNE.	6		
228	Coosa and Clay	do	3.30 p.	NE.	10		
229	Pike	Mar. 3	11.30 p.				
230	Hale	Mar. 26	1 p.		1		
231	Pike and Crenshaw.	Mar. 27	12.30 a.	NE.	9	(2)	2,000
232	Walker	May 27	8.45 p.	NE.	5	50	200,000
233	Jefferson	do	8.45 p.	NE.	26	38	65,000
234	Blount	do	9.15 p.	E.	1	15	40,000
235	Talladega	May 28	12.45 a.	SE-E.	1	4	125,000
236	Madison	May 27–28.	Night		6	16	
237	Tuscaloosa	do	Night	E.	1		(7)
		1918					
238	Baldwin	Jan. 11	p.	NE.			
239	Pike	do	p.		1		
240	Houston	do	1.40 p.	NE.	12	10	100,000
241	Elmore	Feb. 14	—p.	ENE.			10,000
		1919					
242	Escambia, Crenshaw, Pike, and Barbour.	Mar. 5	12.35 p.	NE.	5	16	200,000
243	Mobile	May 26	9 a.			(1)	700
		1920					
244	Elmore, Tallapoosa, and Chambers.	Mar. 28	2.30 p.	ENE.	17	40–50	150,000

[6] Considerable.
[7] Several thousand.

TABLE 1.—*Tornadoes reported in Alabama: Earliest record to April 1, 1925*—Continued

Number on chart in figures	County	Date	Time	Direction of path	Number of persons—		Property loss
					Killed	Injured	
		1920					
245	Pike	Mar. 17	Noon	NE			$5,000
246	Calhoun	Mar. 28			1		
248	Marion, Franklin, Colbert, and Lawrence.	Apr. 20	9 a.	NE	44	315	1,000,000
249	Walker, Cullman, Morgan, and Madison.	do	Noon	NE	46	215	1,000,000
		1921					
250	Pickens	Mar. 9	2 a.	NE		2	1,200
251	Baldwin	Mar. 31	9.15 a.	E		5	500
252	Lamar, Marion, Franklin, Colbert, and Lauderdale.	Apr. 15–16.	Midnight.	NE			
253	Choctaw	Apr. 16	6.30 a.	NE			10,000
254	Tuscaloosa and Jefferson.	do	6.30 a.	NE	5	12–15	200,000
255	Hale	do	10 a.	NW		2	
256	Dallas, Autauga, Elmore, Tallapoosa, and Chambers.	do	12.05 p.	ENE	2	9–10	1,000,000
		1922					
257	Coffee	Feb. 5	3 a.	NE	1	12	40,000
258	Mobile	Mar. 14	1.30 p.	NE			
259	Limestone	do	4 p.	NE			
260	Lee	Mar. 19	Dusk	ENE	2		1,000
261	Cullman	Mar. 14	8 p.	NE			
262	Colbert and Lawrence.	Mar. 31		NE			
263	Cullman	do	3 a.	NE		3	100,000
264	Pike	Apr. 5					
		1923					
265	Baldwin	Nov. 29	8 a.	NE	1	2	12,000
		1924					
266	Walker	Feb. 4	5 p.	NE		3	5,000
267	Jefferson	do	5.30 p.	NE	3	5	25,000
268	Autauga	Apr. 30	2.45 a.	E		8–10	30,000
269	Butler, Bullock, and Macon.	do	4.50 a.	NE	8	31	47,000
270	Chambers	do	4.30 a.		1	6	25,000
271	Lee	do	5 a.		4	13	10,000
272	Barbour	do	7 a.			12	40,000
273	Barbour and Pike.	do	6 a.		1	25	20,000
274	Limestone	May 26	11.45 p.		8		5,000
275	Pickens	May 27	Early a.		1	4	10,000
276	Walker	do	2.15 a.		11	7	19,000
277	Marion	do			1	2	
278	Dallas	do	3.40 a.			2	3,000
279	Etowah	do	Daybreak.			8	
		1925					
280	Coffee	Jan. 10	8 a.			(?)	5,000
281	Coffee	do	Noon			1	
282	Pike	do	do				

During the period 1794 to March, 1925, at least 283 tornadoes have occurred in Alabama. Since 1871 only three years have passed without at least one, namely, 1872, 1877, and 1907. The year of greatest frequency was 1884, with 31 reported; 1885 and 1913, were next with 15 each, and 14 were reported in 1924. There can be no doubt that tornadoes are more frequent in some years than in others, but it is difficult to make comparisons, because of the incompleteness of the records, and the variation in vigilance of those who have recorded them in the past. For example, the large number recorded during 1884–85, is partly due to the special efforts of Finley to secure a record of all tornadoes; probably, however, these years were unusually stormy, particularly 1884. After unusually destructive tornadoes occur, newspapers are likely to print articles concerning them, and for this reason many minor storms are noted at such times that would otherwise remain unrecorded. Another source of difficulty is the fact that in some years several tornadoes occur on the same date and under about the same conditions, while in other years fewer tornadoes occur, but are scattered more throughout the season. The total for each year has been computed, however, and is given in Table No. 2.

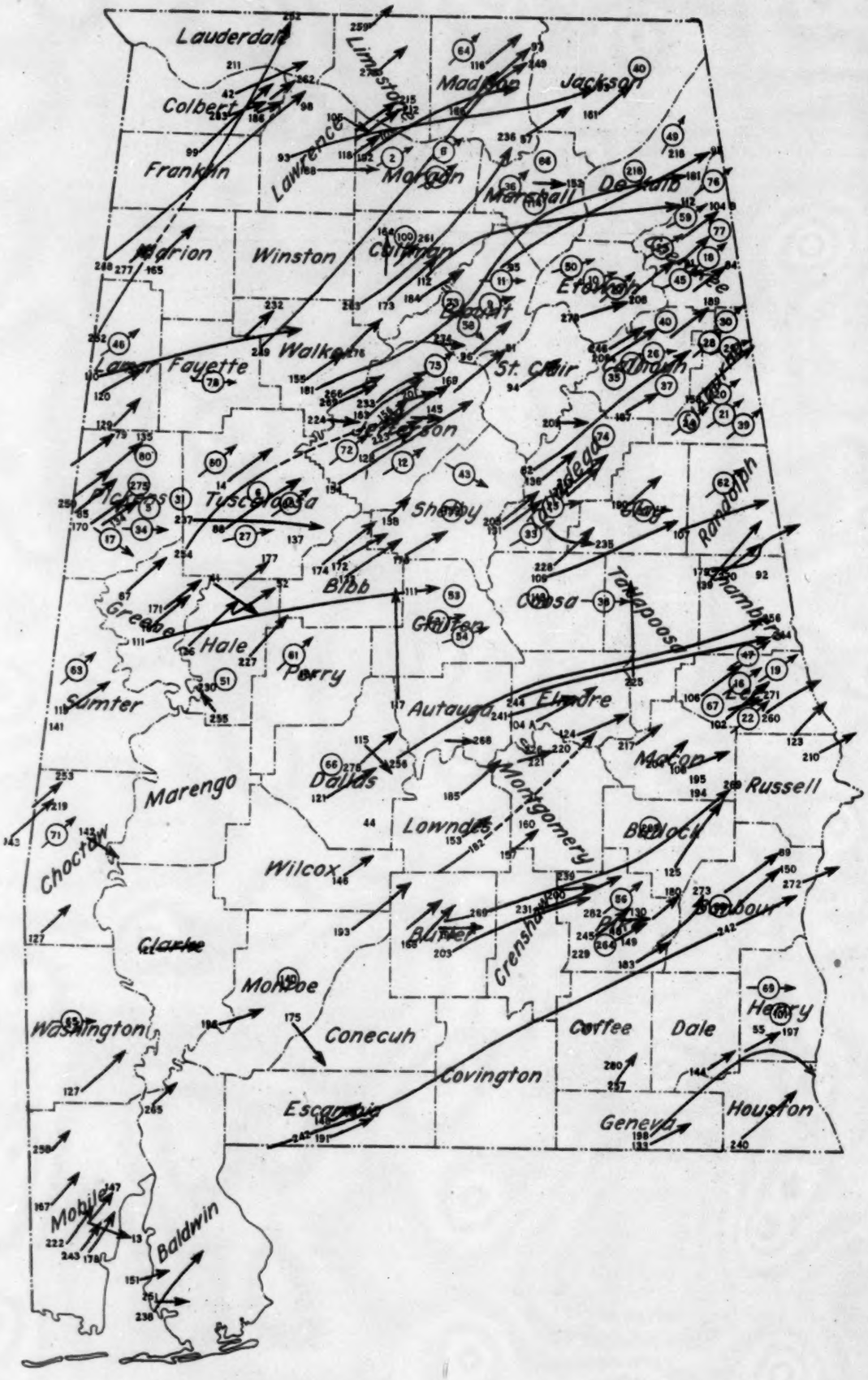
The average yearly frequency for Alabama as figured by Finley for the period 1822–1888 is 1.6. The average yearly frequency figured for the 54-year period, 1871–1924, inclusive, during which time reports may be assumed to be fairly complete, is 4.5. It is not likely that there has been an actual increase in frequency; the apparent increase is probably due entirely to the increase in population and the consequent increased facilities for obtaining reports.

TABLE 2.—*Total number of tornadoes reported each year in Alabama, 1794 to March, 1925, inclusive*

Year	Number	Year	Number	Year	Number
1794	1	1868	2	1898	1
* * *		1869	3	1899	7
1822	1	1870	3	1900	7
1823	2	1871	1	1901	2
1824	1	1872	0	1902	2
* * *		1873	1	1903	4
1829	1	1874	5	1904	2
1830	1	1875	4	1905	1
* * *		1876	2	1906	1
1834	1	1877	0	1907	0
* * *		1878	2	1908	3
1840	5	1879	1	1909	9
* * *		1880	5	1910	3
1842	1	1881	5	1911	1
1843	1	1882	8	1912	6
* * *		1883	6	1913	15
1854	1	1884	31	1914	1
1855	1	1885	15	1915	2
1855	1	1886	5	1916	6
* * *		1887	3	1917	11
1857	1	1888	2	1918	4
1858	1	1889	1	1919	2
* * *		1890	4	1920	5
1861	1	1891	2	1921	7
* * *		1892	2	1922	8
1863	1	1893	4	1923	1
1864	1	1894	2	1924	14
* * *		1895	5	1925	3
1866	3	1896	1		
1867	4	1897	1		

The number of tornadoes that occurred in each month of the year and the corresponding percentage of the total number for the period have been determined, and appear in Table No. 3. It will be seen that tornadoes occur with greatest frequency in late winter and spring, but have occurred occasionally in every month of the year except September. The month of maximum frequency is March, with 80 reported, or 29.4 per cent of the total number. The next most frequent month of occurrence is April, with 69 reported, or 25.4 per cent of the total number, while February and May rank next in order of frequency with 12.5 and 10.7 per cent, respectively. From July to October, inclusive, tornadoes are rare, with only 2.2 per cent of the total number reported in this third of the year. There is a slight, but noticeable, rise in frequency in November and a falling off in December, the percentages in these months being 5.5 and 3.3, respectively. These facts have an important bearing on the question of the origin of tornadoes in this region. The scarcity of tornadoes during the summer months, when thunderstorms are most frequent, indicates that they seldom, if ever, develop in the heat thunderstorms so prevalent in the Gulf States during the summer. Some of those that occur in summer and autumn develop even in West India hurricanes. It is interesting to compare the monthly frequency of tornadoes in Alabama with the monthly frequency of thunderstorms at Montgomery. Table No. 4 shows the number of thunderstorms that have occurred in each month during the period 1872–1924, inclusive, with the

W. R. S. FIG. 3—Tornado tracks, Alabama, 1794 to March, 1925.



October, 1925. M. W. R.

corresponding percentages of the total number in the period. Nearly two-thirds of all the thunderstorms occur during the four months May to August, inclusive, while less than 15 per cent of the tornadoes occur during the same period, and most of those in May. Figure 1, the graph of the percentage columns in Tables 3 and 4, brings out very clearly the wide difference in the seasonal distribution of thunderstorms and tornadoes in this section of the country.

TABLE 3.—*Total number and percentage of tornadoes recorded in Alabama, by months, 1794–March, 1925, inclusive*

Month	Number	Percentage	Month	Number	Percentage
January	22	8.1	September	0	0
February	34	12.5	October	1	0.4
March	80	29.4	November	15	5.5
April	69	25.4	December	9	3.3
May	29	10.7			
June	8	2.9	Total	272	100.0
July	3	1.1	Month unknown	11	
August	2	0.7			

TABLE 4.—*Total number and percentage of thunderstorms at Montgomery, Ala., by months, 1872–1924, inclusive*

Month	Number	Percentage	Month	Number	Percentage
January	73	2.7	July	508	19.0
February	121	4.5	August	466	17.5
March	193	7.2	September	175	6.6
April	211	7.9	October	47	1.8
May	292	11.0	November	56	2.1
June	472	17.7	December	54	2.0

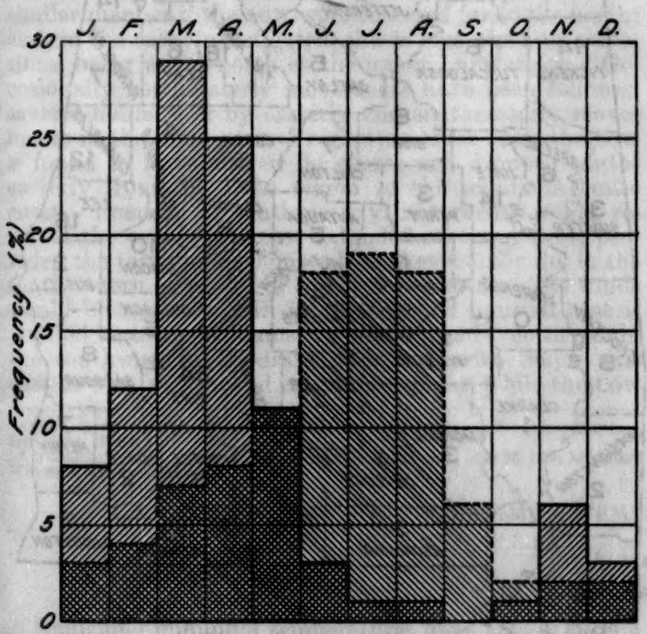


FIG. 1.—Occurrence of tornadoes and thunderstorms by months: Tornadoes, light shading; thunderstorms, dark shading

Table No. 5 and Figure 2 show the hourly frequency of tornadoes in Alabama. The time of occurrence which was available in 194 cases has been tabulated by hours and the percentages in each hour determined. It is an interesting fact that the tornadoes occurred at all hours of the day and night. The hours of greatest frequency are from 4 p. m. to 7 p. m., with 14 out of the 194, or 7.2 per cent, in each of the three hours. The hours of next greatest frequency are 8–9 p. m. and 12–1 a. m., with 6.7 per cent in each. The hour of least frequency is 7–8 a. m., with only one case out of the 194. Approximately three times more tornadoes occur during the four hours 4–8 p. m. than in the corresponding period in the morning. In general it may be stated that, roughly, there is a gradual hourly increase in frequency from about sunrise to sunset, and a gradual hourly decrease from about sunset to sunrise, with nearly an equal number in each period, though with a few more during the night.

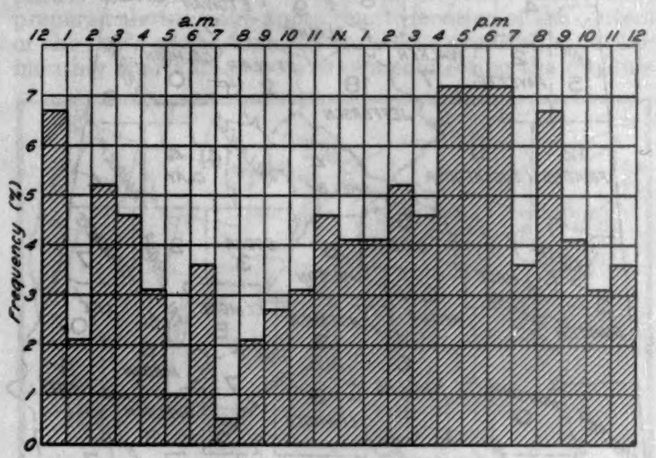


FIG. 2.—Hourly frequency of tornadoes in Alabama

TABLE 5.—*Hourly frequency of tornadoes in Alabama, 1794–March, 1925, inclusive*

A. M.			P. M.		
Hour	Total number	Per cent	Hour	Total number	Per cent
12-1	13	6.7	12-1	8	4.1
1-2	4	2.1	1-2	8	4.1
2-3	10	5.2	2-3	10	5.2
3-4	9	4.6	3-4	9	4.6
4-5	6	3.1	4-5	14	7.2
5-6	2	1.0	5-6	14	7.2
6-7	7	3.6	6-7	14	7.2
7-8	1	0.5	7-8	7	3.6
8-9	4	2.1	8-9	13	6.7
9-10	5	2.7	9-10	8	4.1
10-11	6	3.1	10-11	6	3.1
11-12	9	4.6	11-12	7	3.6
			Total, a. m. and p. m.	194	100.0

Hour uncertain: a. m., 7; p. m., 13; night, 12; total, 32. Hour unknown: 57.

The tornado tracks (shown in fig. 3) have been located as accurately as possible, and the lengths of the arrows made to indicate approximately the lengths of the paths. The tracks are numbered to correspond with the list in Table No. 1. When the location of the tornado was definitely known, and the direction in which it moved unknown, only the number has been entered at its proper place. In those cases where the exact location in the county was unknown, the number has been placed in the county, within a small circle, and the arrow drawn to show the direction, if known, and omitted if not known. Figure 4 and Table No. 6 show the number of tornadoes that have occurred in each county in the State. On account of the difference in size of the counties, many of which are more than twice as large as

others, it was thought advisable to reduce the number in each county to the number per 1,000 square miles; these numbers as thus computed appear in Figure 5.

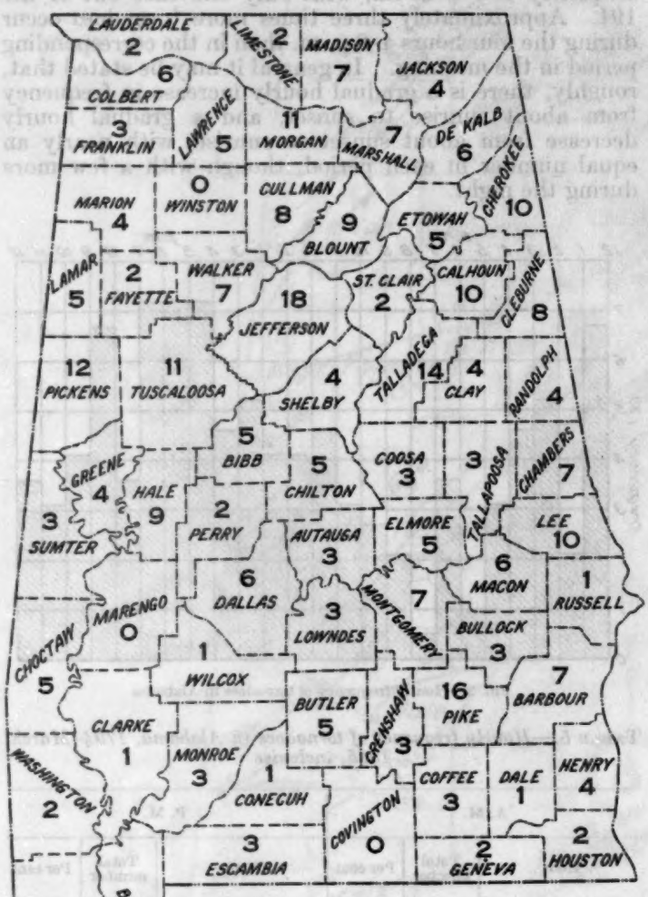


FIG. 4.—Number of tornadoes reported in each county, 1794–March, 1925, inclusive

Tornadoes have occurred in nearly all parts of the State. There is a tendency toward clustering of the tracks in the central and eastern portions of the northern half of the State, and in the central part of the southeastern portion. How much of this is due to incompleteness of reports is impossible to say, but it is believed that the tendency exists, though perhaps not so well marked as appears from the charts. The greatest number, 18, have been reported from Jefferson County; the next greatest number, 16, from Pike County. None have ever been reported from Covington, Marengo, and Winston Counties, although at least one appears to have crossed Covington and Winston. The absence of tornadoes in these three counties is believed to be due solely to lack of reports, as there seems to be no reason why they should be immune. There appears to be a tendency to more frequent occurrence on the northwestern slopes of the mountain ranges in northern Alabama than on the southeastern.

TABLE 6.—*Number of tornadoes in Alabama by counties 1794–March, 1925, inclusive*

County	Total number	County	Total number	County	Total number
Autauga	3	Dallas	6	Marion	4
Baldwin	4	DeKalb	6	Marshall	7
Barbour	7	Elmore	5	Mobile	7
Bibb	5	Escambia	3	Monroe	3
Blount	9	Etowah	5	Montgomery	7
Bullock	3	Fayette	2	Morgan	11
Butler	5	Franklin	3	Perry	2
Calhoun	10	Geneva	2	Pickens	12
Chambers	7	Greene	4	Pike	16
Cherokee	10	Hale	9	Randolph	4
Chilton	5	Henry	4	Russell	1
Choctaw	5	Houston	2	St. Clair	2
Clarke	1	Jackson	4	Shelby	4
Clay	4	Jefferson	18	Sumter	3
Cleburne	8	Lamar	5	Talladega	14
Coffee	3	Lauderdale	2	Tallapoosa	3
Colbert	6	Lawrence	5	Tuscaloosa	11
Conecuh	1	Lee	10	Walker	7
Coosa	3	Limestone	2	Washington	2
Covington	0	Lowndes	3	Wilcox	1
Crenshaw	3	Macon	6	Winston	0
Cullman	8	Madison	7	Unknown	1
Dale	1	Marengo	0		

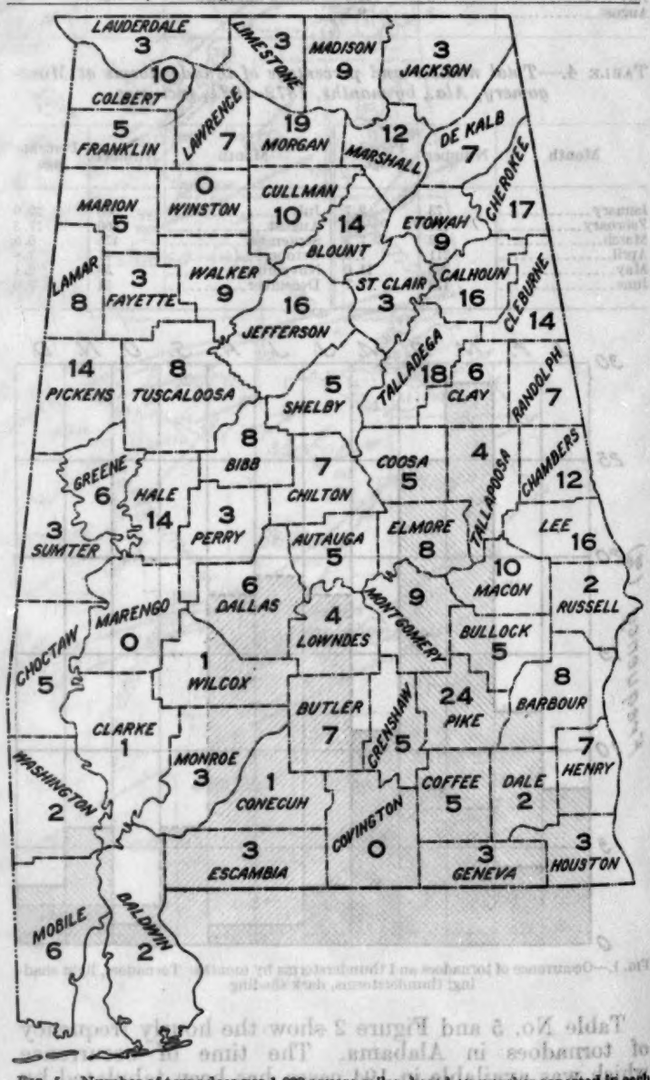


FIG. 5.—Number of tornadoes per 1,000 square miles, based on number reported in each county, 1794–March, 1925, inclusive

An analysis of Figure 3 shows that a far greater number of tornadoes move northeastward than in any other direction, which is the normal direction of movement in most

sections of the country where tornadoes occur. The conditions that give rise to a northeastward movement can then be said to be normal. These normal conditions are an east to northeast movement of the LOW and a north to northeast drift of the winds within the LOW at the point where the tornado occurs, and the velocity of translation is the resultant of the velocities of these two components. After a study of weather maps and storm tracks, it seems that abnormal movements can be explained in this way.

For example, two tornadoes that have developed in West India hurricanes had abnormal movements. A tornado in Tallapoosa County on July 6, 1916, occurred when the hurricane was centered about 275 miles slightly south of east, near Vicksburg, Miss., and when the larger storm was on the recurve and moving northward. The surface wind at Montgomery was southeast, but the lower clouds were from the south; the tornado moved almost exactly north over a path 25 to 30 miles long.

The tornado that occurred 20 miles southwest of Miami, Fla., in the hurricane of September 10, 1919, and, as pointed out by Gray,[1] moved west-northwest with the strong southeast wind that prevailed at the time on the southeast Florida coast; the hurricane at the time was also moving west-northwest.

There is a tendency toward a more easterly movement of tornadoes in the southern part of the State than in the northern; this tendency is frequently noticeable on those occasions when tornadoes occur in northern and southern sections in connection with the same storm, and is probably due to the more easterly winds near the southern end of the LOW or trough. The easterly movements in the northern part of the State could be explained in a similar manner if the LOW were centered far to the north; and, in the cases investigated, this is true, the LOW sometimes being as far north as the upper Lake region. Occasionally northeasterly movements have been followed several hours later by easterly and southeasterly movements in the same general region; in these cases the LOW is found to have altered its course and dropped southeasterly from the Lake region to the middle Atlantic coast. Easterly or southeasterly movements would result if the axis of the LOW extended east and west, provided the tornadoes originated, as they usually do, in the southeastern quadrant of the cyclone, for then the winds would be westerly. An interesting and unusual case is pointed out by Williamson;[2] the tornado occurred in the southwestern quadrant of a LOW with major axis east to west and moved east to southeast, while the LOW was moving slightly north of east. An instance where the tornado originated in the northeast quadrant of the LOW and moved a little west of north is noted by Loveland.[3] The surface wind was southeast and the LOW was moving rather slowly northeastward. Tornadoes originating in the northeast quadrant are comparatively rare, apparently due to the contrary direction of the progressive motion of the LOW and the drift of the winds in that part of the LOW; since it is possible for the vertical temperature gradient to be as steep in the northeast as the southeast quadrant.

To show the relation of tornadoes in Alabama to the parent LOWS, monthly charts and a yearly chart were prepared showing the approximate location of the centers of the LOWS at the time the tornadoes occurred. On the monthly charts lines were drawn connecting the cyclonic

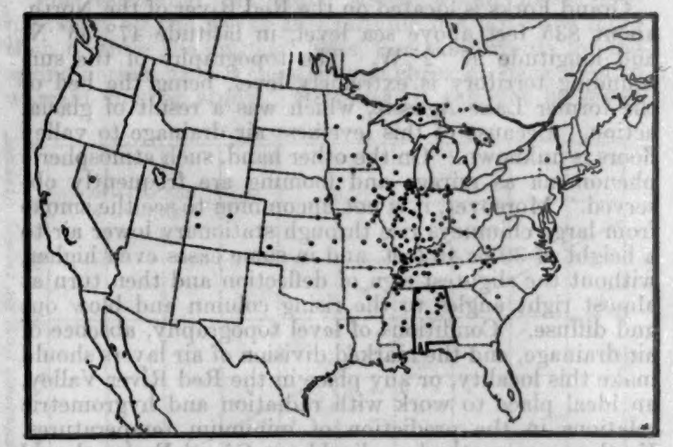


FIG. 6.—Location of the centers of LOWS which were accompanied by tornadoes in Alabama.

centers and the tornado tracks, but this was impracticable on the chart for the year. (Fig. 6.) Tracks of centers of cyclones in the MONTHLY WEATHER REVIEW since 1876 were used, the center, of the individual LOW being obtained from a consideration of its rate of movement. The charts show a wide divergence in the position of the centers, which is to be expected because of their varying size and shape. However, the most dangerous position for the center with respect to Alabama is 300 to 600 miles slightly west of north, more particularly in Illinois, Indiana, or western Kentucky and western Tennessee. Tornadoes occasionally occur when the center of the LOW is over the upper Lake region, but these are found to be greatly elongated, V-shaped LOWS.

[1] Gray, R. W. A Tornado within a hurricane area, MONTHLY WEATHER REVIEW, Sept., 1919, 47: 639.

[2] Williamson, R. M., Tornado in Davidson County, Tenn., May 12, 1923, MONTHLY WEATHER REVIEW, May, 1923, 51: 262.

[3] Loveland, G. A., Tornadoes in eastern Nebraska, April 6, 1919, MONTHLY WEATHER REVIEW, April, 1919, 47: 234.

THE PREDICTION OF MINIMUM TEMPERATURES FOR THE RED RIVER VALLEY

By ALBERT W. COOK

[Madison, Wis., August 19, 1925]

Damaging minimum temperatures have always been a matter of grave concern to the shipper of perishable goods, to the grower of citrus fruits in southern California and deciduous fruits in Washington and Oregon, to growers of cranberries in Wisconsin and New Jersey—in fact to all businesses dealing with commodities which suffer damage when exposed to low temperatures. And now, with the development of the potato industry and the advent of sugar beets to the Red River Valley the farmers of that section are confronted with the same problem, the protection of their produce while still in the field and unharvested. Before they will be willing to invest in expensive frost-fighting equipment, methods already in use elsewhere for accurately foretelling the occurrence of damaging minimum temperatures during the critical spring and autumn periods of plant growth must be adapted to the local atmospheric and topographic conditions under which frost occurs.

The general prediction of light, heavy, and killing frosts for considerable areas are made from the morning weather maps and are issued at the time of the regular morning forecast. These forecasts are usually quite ac-

curate, but as they are made from 12 to 21 hours before the damaging temperatures occur and since unforeseen changes often come in the meantime, they are at times quite misleading.

Under these circumstances it becomes important that a definite statement of the expected minimum temperature be made. Such predictions should be made as early as possible, but from 6 to 12 hours warning would give ample time for the effective use of any method now in use on a commercial basis for protection against frost.

The purpose of this paper is to show the best method to be used at Grand Forks, North Dakota, for reducing the complex of meteorological factors involved in forecasting frosts, to simple, usable terms, whereby, from data available the day before, the ensuing minimum temperature may be forecast.

Grand Forks is located on the Red River of the North, about 835 feet above sea level, in latitude 47° 56′ N. and longitude 97° 2′ W. The topography of the surrounding territory is extremely level, being the bed of the former Lake Agassiz, which was a result of glacial action. Because of this levelness air drainage to valley floors is unknown. On the other hand, such atmospheric phenomena as mirage and looming are frequently observed. Moreover, it is not uncommon to see the smoke from large chimneys rise through stationary lower air to a height of 30 or 40 feet, and in some cases even higher, without the slightest sign of deflection and then turn at almost right angles to the rising column and blow out and diffuse. Conditions of level topography, absence of air drainage, and the marked division of air layers should make this locality, or any place in the Red River Valley, an ideal place to work with radiation and hygrometric relations in the prediction of minimum temperatures. Further, any method applicable at Grand Forks, should be applicable at any other place in the valley, using data appropriate to the latitude in each case.

Choosing of frost periods.—The first step was the determination, from climatological data,[1] of those periods during which frost is most apt to occur and the periods critical to crop growth in this locality.

It was found that the last killing frost in the spring has never occurred later than June 14, nor earlier than April 20, at Grand Forks. The critical period for the spring was therefore set from April 15 to June 15. In the fall the earliest occurrence of a killing frost was on August 20, and the latest on October 13. From these facts the critical period was set from August 15, to October 15.

From Weather Bureau records of the Grand Forks station covering these critical periods for the preceding five years, all nights when conditions were favorable for free radiation and frost were taken as a basis for the work, about 70 in the spring and an equal number in the fall. However, frosts severe enough to cause damage to plants were recorded only about one-fourth of the time when conditions for frost formation were favorable. Severe frosts occur about once in every 20 days during the critical periods.

Median-temperature hour method.—This method is based on the belief that the median or halfway temperature between the maximum of the day and the minimum of the following morning occurs at about the same time each day during clear, calm weather. Its application consists of determining the time of the median-temperature hour from a series of thermograph traces for past years. After this it becomes a simple matter to observe the temperature at that hour, subtract the observed reading from the maximum of the day, and then subtract this difference from the temperature observed at the median hour. The result is the ensuing minimum temperature. As an example: In April the median hour was found to be 9.17 p. m. The highest temperature for the day was 76° F. and at 9.17 it had fallen to 60° F.; the difference, 16°, subtracted from 60° leaves 44° as the expected minimum temperature for the following morning.

In testing the applicability of this method to Grand Forks, the time of the median hour for each month was found to be 9.17 p. m. for April; 10.25 p. m. for May; 9.48 p. m. for June; 9.53 p. m. for August; 8.54 p. m. for September, and 8.03 p. m. for October.

As a first check upon the method, the minimum temperature which would have been predicted by it was computed for all of the days under consideration, during the critical periods and comparisons then made with the observed minima. There were very few deviations of over 5°. Although it gives a fairly close check with the data from which it was calculated, it is more or less empirical. The real value, if any, will be shown in the practical application to new data.

Hygrometric relations.—The more important factors which determine the amount of drop in temperature during the night over a given locality are as follows: (1) Radiation of heat from the earth and the air and the temperature of the radiating surface; (2) importation of cold or warm air by winds and their effect in mixing the surface air so as to prevent temperature inversion; (3) the conditions of the sky; and (4) the local topography.

Thus we find that the factors responsible for the change in temperature may be any of, or a combination of, the following: Wind direction and velocity, humidity, dew point, clouds, temperature at the time of the observation, which for the purposes of this study will be taken as the temperature of the radiating surface, and the topography of the surroundings.

Although absolute calms are rare in this locality, the effect of the wind will be slight if the velocity is small, hence we may neglect this factor. Due to the level character of the land, factor five will not be considered. When conditions are favorable for free radiation the sky is clear and we may therefore neglect the third factor listed above.

The chief remaining factors are the radiation of heat, the temperature of the radiating surface, and some function of the humidity. But since the relative humidity and the dew point involve the air temperature at the time of the observation, we may drop the temperature of the radiating surface and thus finally leave humidity as the only factor to be considered, a factor which, presumably, exerts the greatest influence on decreases of temperature.

Since water vapor in the atmosphere is the most effective absorber of radiation from the earth, it follows that the amount of water vapor in the air above a given locality has considerable influence on the rate of fall of temperature at that place during nights when radiation conditions prevail. The temperature will fall more slowly when the moisture content is high than when it is low, other conditions being the same.

We may express the relation between relative humidity, dew point, and the expected minimum temperature, mathematically as follows:

$$\text{Minimum} = f(\text{dew point, relative humidity})$$

[1] Summary of climatological data for the United States, section 32; eastern North Dakota. Bulletin, Frost Data at Grand Forks, North Dakota, H. E. Simpson.

where f is some unknown function, which, if determined, will give an equation permitting the calculation of the minimum temperature.

The next step was to plot the depression of the minimum temperature below the evening dew point against the evening relative humidity. The arrangement of the dots on the plot approximated a straight line, tending to show a fairly close linear relation between the factors plotted.

To test this relationship the Pearsonian coefficient of correlation was computed and found to be -0.8243 ± 0.0249. The negative sign indicates that as the values of the relative humidity increase, the values of the depression of the minimum temperature must decrease. The value as found shows a high degree of correlation, in harmony with the approximately linear relationship shown by the plot.

To make the data of practical value the curve of "best fit" was computed by the method of least squares, and the constants of the linear equation, showing the

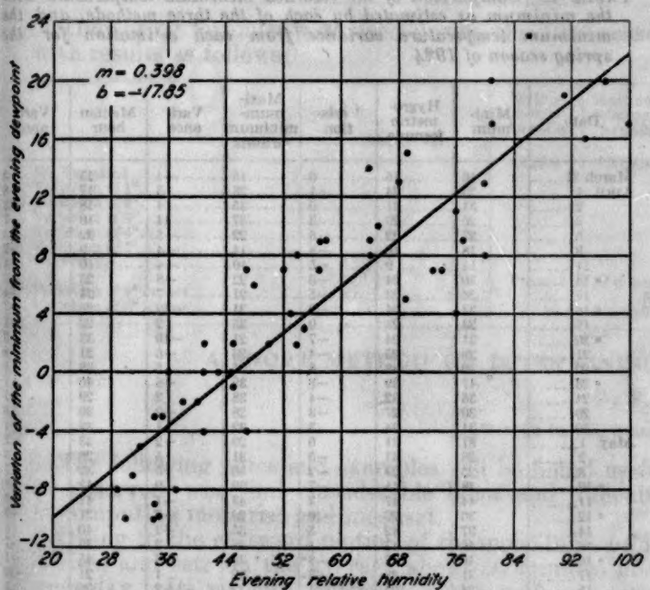


FIG. 1.—Relation between the evening relative humidity and the variation of the minimum from the dew point

relationship between the factors, were found. Using these constants and putting in the proper terms, our equation is:

$$Dp - Min = 0.398\ RH - 17.85,$$

or,

$$Min = -0.398\ RH + 17.85 + Dp$$

where Dp represents the dew point, RH the evening relative humidity and Min the expected minimum temperature. 0.398 is the slope of the line and -17.85 is the intercept on the y axis.

The distribution of the dots as plotted and the line given by the equation are shown in Figure 1, for the spring period.

The minimum temperature which would have been predicted by the method was computed for all days under consideration. In only two cases did it vary more than 6° from the actual recorded value.

Several direct methods were tried, such as plotting the minimum temperature against the relative humidity, and also against the depression of the wet bulb reading and the depression of the dew point below the evening dry temperature was plotted against the minimum temperature. The results were in no way indicative of of a close relationship. The dots were widely scattered and the correlation coefficient in all cases was below 0.5, which would indicate a nonlinear relationship.

In the consideration of the hygrometric data for the fall periods it was treated as a separate problem, but the same methods were used as for the spring period.

A dot chart was constructed, Figure 2, and the coefficient of correlation was computed as before and found to be -0.6 ± 0.091. Though not as high as the value for the spring, it is indicative of a linear relation.

The equation of the line of "best fit" may be expressed as follows:

$$Min = -0.2536\ RH + 10.96 + Dp$$

The estimated minimum which would have been predicted by the use of this formula did not vary more than 6° from the actual. This, like the formula for the spring period, gave a close enough check on back data to warrant further study. However, it can not be given

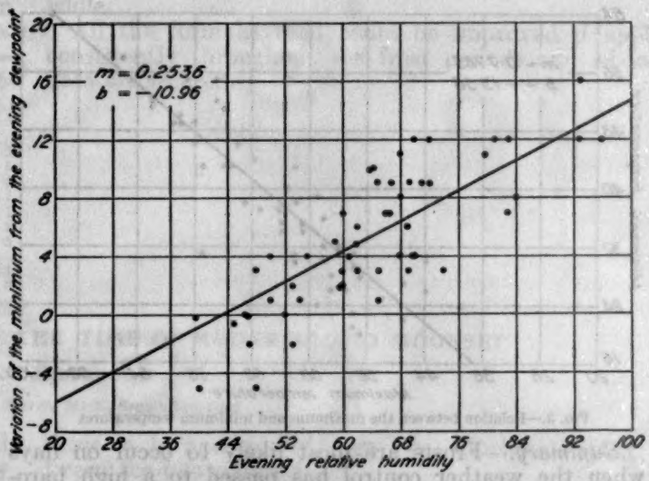


FIG. 2.—Relation of the evening relative humidity to the variation of the minimum from the dew point

much weight until we have further experimental evidence to show that it is satisfactory and usable.

Maximum-minimum temperature relations.—In the consideration of the median-hour method, it was shown that the halfway temperature between the maximum of one day and the minimum the following morning occurs at about the same time on days when the wind is light and the sky clear. If this is true, we should expect to find a direct relation between the maximum temperature to-day and the ensuing minimum temperature. The higher the maximum temperature to-day the higher should the minimum temperature be to-morrow morning, if conditions favoring active radiation prevail.

It follows, then, that the change in temperature between the maximum of the day and the minimum of the following morning is a function of the maximum and minimum temperatures. We may express this as follows:

$$\text{Change} = f\,(\text{maximum, minimum})$$

By plotting the maximum temperature against the minimum of the following morning we get an arrangement of dots, shown in Figure 3, for the spring and a similar arrangement for the fall. The coefficients of correlation were 0.8824 ± 0.0184 and 0.74 ± 0.080 for the spring and fall, respectively. These relatively high

values gave sufficient proof of its approximation to a straight line to warrant the use of the data as plotted.

The next step was to compute the constants of the linear equation where

$$\text{Min} = m(\text{max}) + b$$

Min represents the expected minimum temperature, Max the maximum of the day, and m and b constants representing the slope of the line and the intercept on the y axis, respectively.

Substituting the values of m and b as found, we get

Spring: Min = 0.778 Max − 13.58.

Fall: Min = 0.802 Max − 13.50.

This formula is similar to the one used by Nichols at Grand Junction, Colo.[2]

This, like all of the other methods, gives a close check upon the data from which it was computed, but the practical tests on new data will give the real value of the equation.

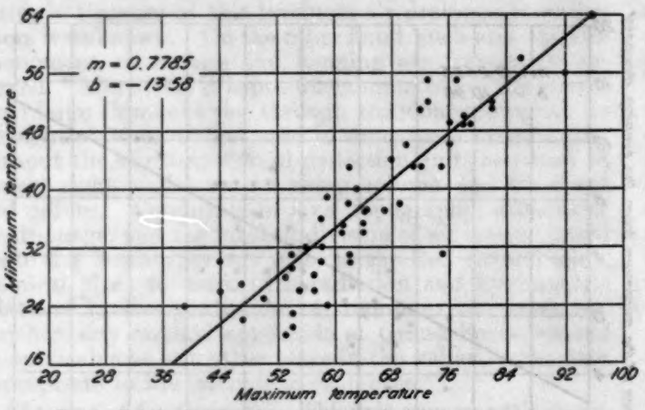


FIG. 3.—Relation between the maximum and minimum temperatures

Summary.—Frosts are most likely to occur on days when the weather control has passed to a high barometric area with its relatively clear skies and light winds. The prediction of damaging minimum temperatures during the critical periods in spring and fall is of vital importance to the agricultural interests of this vicinity.

After a careful examination of data for past years for days on which conditions were favorable for free radiation and frost, three methods for predicting the minimum temperatures which result in damage to crop growth were found applicable to Grand Forks. They are, first, the maximum-minimum temperature relation; second, the hygrometric-minimum temperature relation; and the median-temperature hour method.

In the first method a direct and approximately linear relation between the maximum of the day and the ensuing minimum temperature was found. The relation is expressed by a linear equation. By this method it is only necessary to observe the maximum as soon as it occurs in the afternoon, substitute its value in the formula and solve for the minimum temperature.

A direct relation between the humidity at the time of the evening observation (7 p. m. ninetieth meridian time) and the depression of the ensuing minimum temperature below the evening dew point was found. This also can be expressed as a linear equation.

Both formulas (spring and fall) gave a close check with the data from which they were computed.

[2] MONTHLY WEATHER REVIEW, Supplement 16.

The formulas were computed by working on the assumption that the moisture content of the air is the most effective agent in reducing the effect of radiation from the earth on clear, still nights.

The third method finds its application at a later hour than either of the above methods. The median hour varies from 8.05 p. m. to 10.25 p. m. as was shown in the discussion of the method. The use of this method was explained.

Application.—Beginning with March 31, 1924, the three methods of predicting the minimum temperature were used, on the basis of data available the day before and taken at the regular evening observation on all nights when conditions were favorable for free radiation. The following table shows the minimum temperature as given by each of the three different methods together with the variance of the estimated minimum temperature from the actual recorded value from March 31 to May 31, 1924.

TABLE 1.—*Comparison of the recorded minimum temperature with the minimum as estimated by each of the three methods, and the minimum temperature variance from each estimation for the spring season of 1924*

Date	Minimum	Hygrometric formula	Variation	Maximum-minimum formula	Variance	Median hour	Variance
March 31	16	16	0	15	−1	13	−3
April 1	25	24	−1	28	3	17	−8
2	31	31	0	35	4	18	−13
3	26	29	3	37	11	19	−7
5	27	22	−5	22	−5	22	−5
9	18	10	−8	14	−4	9	−9
11	14	9	−5	10	−4	10	−4
• 13	30	24	−6	22	−8	25	−5
17	28	23	−5	21	−7	24	−4
• 18	33	24	−9	21	−12	26	−7
19	23	23	0	25	2	22	−1
• 20	31	24	−7	21	−10	33	2
21	29	25	−4	23	−6	21	−8
• 22	30	38	8	35	5	38	8
• 23	47	39	−8	39	−8	48	1
24	36	32	−4	38	2	29	−7
29	30	27	−3	28	−2	30	0
30	31	34	3	32	1	32	1
May 1	31	31	0	29	−2	33	2
2	26	31	−5	31	5	26	0
3	25	27	−2	30	5	32	7
• 10	48	41	−7	39	−9	42	−6
11	44	47	3	43	−1	41	−3
• 12	30	20	−10	23	−7	21	−9
14	37	42	5	35	−2	40	3
15	46	47	1	48	2	39	−7
• 16	46	38	−8	38	−8	45	−1
17	31	28	−3	32	1	21	−10
18	24	25	1	22	−2	26	2
• 19	35	29	−6	28	−7	36	1
20	25	24	−1	26	1	25	0
22	31	33	2	32	1	31	0
23	28	23	−5	21	−7	25	−3
24	30	27	−3	26	−4	32	2
26	35	34	−1	38	3	33	−2
27	37	40	3	36	−1	36	−1
28	41	40	−1	38	−3	37	−4
29	34	34	0	35	1	44	10
30	35	35	0	37	2	35	0
31	39	43	4	42	3	40	1

• Indicates change of cloud conditions after prediction was made.

Omitting the cases where the temperature fall was influenced by cloud conditions, a condition purposely excluded in the development of the formula, and summarizing the table we get:

	Hygrometric formula	Maximum-minimum formula	Median-temperature hour method
	Nights	*Nights*	*Nights*
No variation	6	0	5
Variation of 1°	6	8	4
Variation of 2°	2	8	4
Variation of 3°	7	4	4
Variation of 4°	3	4	3
Variation of 5°	6	3	1
Over 5°	1	4	10
	Per cent	*Per cent*	*Per cent*
Variation of 3° or less	67.7	64.5	58.1
Variation of 5° or less	97.5	87.1	64.5

It is readily to be seen that the values given by the hygrometric formula are the closest. In all cases where cloud conditions changed after the time of the observation the estimated minimum temperature varies more than 5°. If the evening weather map could have been used in conjunction with the formula the clouds could have been determined beforehand.

During the fall period there were 17 days when conditions were favorable for free radiation and frost. The two formulas gave the following results:

	Hygrometric formula	Maximum-minimum formula
	Nights	*Nights*
No variation	2	0
Variation of 1°	5	4
Variation of 2°	1	0
Variation of 3°	3	2
Variation of 4°	3	3
Variation of 5°	1	0
Over 5°	2	6
	Per cent	*Per cent*
Variation of 3° or less	64.7	35.3
Variation of 5° or less	88.2	64.7

The spring formulæ were used during the 1925 season with results as follows:

	Hygrometric formula	Maximum-minimum formula
	Nights	*Nights*
No Variation	3	2
Variation of 1°	1	5
Variation of 2°	4	4
Variation of 3°	6	1
Variation of 4°	2	1
Variation of 5°	3	2
Over 5°	2	6
	Per cent	*Per cent*
Variation of 3° or less	66.7	57.1
Variation of 5° or less	90.5	71.5

Conclusion.—The work described in this paper was of a preliminary nature, the data secured in one or two seasons being too meager to form the basis of any definite conclusions. However, the results obtained by using the two formulæ were of such a nature as to warrant further application and study. Use of the evening weather map is necessary in order to determine the cloud conditions in advance. Also, the probable influence of the wind in preventing stratification of the surface air could be determined from the evening map.

The formula alone can not be counted upon too strongly, but if used in conjunction with the evening weather map reliable predictions of the expected minimum temperature can be made.

The percentage of verification of forecasts from the maximum-minimum formula was not as high as that of the hygrometric formula, but was sufficiently high to justify its use in connection with the hygrometric formula and the weather map.

The median-temperature hour method did not give high enough verification to make its further use worth while.

All the formulæ used could be improved if applied consistently throughout the frost periods and as more data are secured.

A SHORT METHOD OF DETERMINING THE TIME OF MOONRISE AND MOONSET

By F. N. HIBBARD

[Weather Bureau, Grand Haven, Mich., September, 1925]

The following notes and examples will be found useful to observers who find considerable labor and difficulty in computing moonrise and moonset.

Owing to the eastward motion of the moon in its orbit, it rises and sets on the average about 50 minutes later each day. Its velocity, however, is not uniform, nor is its path at a constant angle with the horizon, and the actual times of rising and setting are irregular, the lag varying from less than a half hour to considerably more than an hour.

The Weather Bureau has therefore furnished to each of its stations a nautical almanac and a set of auxiliary tables, the almanac being good for one year and the tables for many years. The almanac gives the risings and settings for various latitudes along the Greenwich meridian, and the tables give the corrections necessary to adapt the Greenwich figures to the Weather Bureau station.

To illustrate the use of the two, Table 1 gives the auxiliary figures as supplied to the Cincinnati station, and Table 2 shows how they are applied to the almanac figures.

Cincinnati lies between the latitudes of 35° and 40°. These two columns in the almanac will therefore be marked by heavy red or blue pencil (see columns a and b in Table 2). Cincinnati lies closer to the 40° latitude, therefore the corrections from the Auxiliary Table 1, A, will be applied to the 40° column (column b). These corrections are given in column c. Note that the corrections are plus when the figures in a are greater than those in b, and minus when less, Cincinnati lying between the two columns.

The results of the corrections are the main figures of column d. After the main figures are entered in pencil for the month, the differences (italic figures in column d) are entered in red ink. To the left of the differences the plus corrections from Auxiliary Table 1, B, are then entered in black ink (bold-face figures in column d), using the red figures for argument. Column e plus column f plus column g, the standard time correction, gives column h, the standard time of moonrise for the date and station. The standard time correction is plus when the station is west of its standard meridian, and minus when east.

Moonset is found in the same manner by using the moonset page in the almanac.

In actual practice the figures of column d only are set down, using the proper squares of Form 1078 for the purpose, the final figures, column h being entered directly in the daily local record, corrections c, f, and g being applied mentally. It is thus possible to list the essential figures, column d, for the entire year on two sheets of 1078, one for the moonrise and one for the moonset. And at no point in the operation has any figure been listed twice. The saving of time by this method is considerable.

In summarizing the operation, it may be helpful to know just where we are at the different points. Column a gives the time of moonrise on the Greenwich meridian for latitude 35°, and column b, for latitude 40; while column c gives the latitude correction. Column d gives

the time (European system) on the Greenwich meridian at latitude 39° 6′, and column e the same time on the American system. Column f allows for the lag of the moonrise, or the time lost in the approximately six-hour trip from the Greenwich meridian to the Cincinnati meridian. And column g corrects to standard time. Column g may be eliminated to advantage by reconstructing Auxiliary Table B to include the standard time correction.

A further shortening of the computation may be effected by combining Table A and Table B and the standard time correction in a single table, card form, by the use of which the times of moonrise and moonset can be found directly by inspection. Table 3 illustrates such a form, made for Cincinnati. By using it in conjunction with column b, the figures in column h are arrived at directly, except in two cases, where the card gives a value one minute off. This one-minute error occurs two or three times per month and is due to the fact that the card applies the Table B corrections to the differences in column b instead of to the differences in column d. The card form is exceptionally rapid and is commended to all stations in the Bureau.

TABLE 1.—*Auxiliary tables for computing the time of moonrise and moonset at Cincinnati, Ohio*

Latitude, 39° 6′ north; =40°−0.9°. 0.9°/5°=0.18
Longitude, 84° 30′ or 5.63 hours west of Greenwich. 5.63/24=0.235

A.—*Latitude correction.* (*0.18×tabular difference for latitude*)

Tabular difference (minutes)	0	1	2	3	4	5	6	7	8	9
	Correction (minutes)									
0	0	0	0	1	1	1	1	1	1	2
10	2	2	2	2	3	3	3	3	3	3
20	4	4	4	4	4	4	5	5	5	5

B.—*Longitude correction.* (*0.235×tabular difference for one day*)

Tabular difference (minutes)	0	1	2	3	4	5	6	7	8	9
	Correction (minutes)									
20	5	5	5	5	6	6	6	6	7	7
30	7	7	8	8	8	8	8	9	9	9
40	9	10	10	10	10	11	11	11	11	12
50	12	12	12	12	13	13	13	13	14	14
60	14	14	15	15	15	15	16	16	16	16
70	16	17	17	17	17	18	18	18	18	19
80	19	19	19	20	20	20	20	20	21	21

TABLE 2.—*Computation of moonrise and moonset at Cincinnati, Ohio, June, 1925*

[Latitude 39° 6′; longitude 84° 30′]

	a	b	c	d	e	f	g	h
					p. m.			p. m.
1	13 20	13 18	±0	13 18 +15 64	1.18	+15	−22	1.11
2	14 21	14 22	±0	14 22 +15 65	2.22	+15	−22	2.15
3	15 24	15 28	−1	15 27 +16 68	3.27	+16	−22	3.21
4	16 30	16 36	−1	16 35 +17 71	4.35	+17	−22	4.30
5	17 38	17 48	−2	17 46 +17 71	5.46	+17	−22	5.41
6	18 48	18 59	−2	18 57 +16 70	6.57	+16	−22	6.51
7	19 56	20 10	−3	20 07 +15 65	8.07	+15	−22	8.00
8	21 01	21 14	−2	21 12 +13 57	9.12	+13	−22	9.03
9	21 59	22 11	−2	22 09 +12 49	10.09	+12	−22	9.59
10	22 49	23 00	−2	22 58 +10 42	10.50	+10	−22	10.46
11	23 33	23 41	−1	23 40	11.40	+9	−22	11.27
12				+9 37	a. m.			a. m.
13	0 12	0 18	−1	0 17 +8 33	0.17	+8	−22	12.03
14	0 47	0 50	−1	0 49 +7 31	0.49	+7	−22	12.34
15	1 21	1 20	±0	1 20 +7 31	1.20	+7	−22	1.05
16	1 53	1 50	+1	1 51 +7 30	1.51	+7	−22	1.36
17	2 26	2 20	+1	2 21 +8 32	2.21	+8	−22	2.07
18	3 00	2 52	+1	2 53 +8 35	2.53	+8	−22	2.39
19	3 36	3 26	+2	3 28 +9 38	3.28	+9	−22	3.15
20	4 16	4 04	+2	4 06				

TABLE 3.—*Corrections to apply to time of moonrise and moonset at latitude 40° N., meridian of Greenwich, to obtain the ninetieth meridian time of moonrise and moonset at Cincinnati, Ohio, latitude 39° 06′ N. and longitude 84° 30′ W.*

Long. Diff.	Lat. Diff.	−25 to −20	−19 to −14	−13 to −9	−8 to −3	−2 to +2	+3 to +8	+9 to +13	+14 to +19	+20 to +25
20 to 23		−21	−20	−19	−18	−17	−16	−15	−14	−13
24 to 27		−20	−19	−18	−17	−16	−15	−14	−13	−12
28 to 31		−19	−18	−17	−16	−15	−14	−13	−12	−11
32 to 36		−18	−17	−16	−15	−14	−13	−12	−11	−10
37 to 40		−17	−16	−15	−14	−13	−12	−11	−10	−9
41 to 44		−16	−15	−14	−13	−12	−11	−10	−9	−8
45 to 48		−15	−14	−13	−12	−11	−10	−9	−8	−7
49 to 53		−14	−13	−12	−11	−10	−9	−8	−7	−6
54 to 57		−13	−12	−11	−10	−9	−8	−7	−6	−5
58 to 61		−12	−11	−10	−9	−8	−7	−6	−5	−4
62 to 65		−11	−10	−9	−8	−7	−6	−5	−4	−3
66 to 70		−10	−9	−8	−7	−6	−5	−4	−3	−2
71 to 74		−9	−8	−7	−6	−5	−4	−3	−2	−1
75 to 78		−8	−7	−6	−5	−4	−3	−2	−1	0
79 to 82		−7	−6	−5	−4	−3	−2	−1	0	+1

NOTES, ABSTRACTS, AND REVIEWS

DAYLIGHT ILLUMINATION ON A SLOPING SURFACE: A CORRECTION

By HERBERT H. KIMBALL

In the MONTHLY WEATHER REVIEW for December, 1922, **50**: 625, equation (3) has been improperly used to determine the angle of incidence of a solar ray with a sloping surface. The angle of incidence $(90°-a')$ is best computed by the second method given in the above reference. Mr. Edgar W. Woolard has also called attention to the fact that it may be computed by the law of cosines, as follows:

$$\cos\theta = \cos v \sin a + \sin v \cos a \sin w,$$

in which v = angle between a horizontal surface and the sloping surface,

a = solar altitude,

$90° - w$ = azimuth of sun from the meridian of the place,

and θ = angle of incidence of a solar ray with the sloping surface.

All values given in Tables 8, 9, and 10, pages 625–26 of the above-mentioned REVIEW are too high, with the exception of those for hour angle of the sun from the meridian = 0° (w = 90°). The maximum error occurs when w = 0°. Since the component of the radiation received diffusely from the sky is not affected by the above equation, for surfaces sloping 10° from the horizon the error can not exceed 1 per cent, and may be disregarded. For surfaces sloping 20° from the horizontal the error can not exceed 4 per cent, and is unimportant. For surfaces sloping 30° from the horizontal the error in extreme cases may approximate 10 per cent.

THE BIG TREES AS A CLIMATIC MEASURE

By ERNST ANTEVS

Annual growth rings of certain big trees in various parts of the world have been used as a climatic yardstick, whereby the rainfall record has been pushed back to the very beginnings of recorded history. The nature of the record is of such character, however, as to introduce grave doubts as to the accuracy of the interpretation that has been put upon it by various students. Meteorologists will therefore welcome the contribution that Doctor Antevs has made particularly since it bears directly upon phases of the interpretation of the records which have not hitherto been sufficiently clarified. The work doubtless grew out of the conference on weather periodicities held under the auspices of the Carnegie Institution of Washington in 1923, in which the author participated. In his introduction the setting of the study is described as follows:[1]

* * * In 1911, Professor Ellsworth Huntington, of Yale University, began his measurements on the big tree (Sequoia washingtoniana) in the Sierra Nevada in California, which, since corrections for nonclimatic factors had been applied, enabled him to construct a climatic curve reaching 3,000 years back. The results obtained by Doctor Douglas and Doctor Huntington are of great and many-sided importance and have increased our knowledge of climatic periodicity particularly.

The studies had reached the point where the need of detailed analyses of the factors influencing growth, of easily applied methods of correction, etc., made themselves felt, and therefore this restudy of Doctor Huntington's sequoia material has been carried out under the auspices of the Carnegie Institution of Washington at the request of its president Dr. John C. Merriam. The study has been made possible by Doctor Huntington's generosity in placing all his original material and annotations at the writer's disposal. During the course of the investigation at Yale, Doctor Huntington has aided in word and deed. * * *

Space does not permit detailed reference to the treatment of the material and illustrations; only the outcome of the examination are given, the latter in the author's own words.

On the preceding pages has been shown how the varying rate of growth at different age stages, effects of individual and local nature, flaring, etc., have been eliminated as accurately as possible from the growth curves. The remaining variations of the curves may be due largely to changes in climate and weather, though it must not be thought that every little fluctuation necessarily has climatologic significance. Importance should be attached only to large features.

As stated on this page, separate curves, not published, were calculated from measurements of those parts of trees that are less than 1,301 years old and from those parts that are 1,301 to 2,100 years old. The curves of parts under 1,301 years show fluctuations lacking in the other curves; besides, in these curves the maxima that also occur in the curves of parts 1,301 to 2,100 years old are more pronounced, commence earlier, and last longer.

"DRY" CURVE AND "MOIST" CURVE

The finally corrected curves based upon all trees growing in dry and wet sites, respectively (curves 1 and 2, fig. 7), show better agreement with each other, the greater the material upon which they are based. Therefore the less exact correspondence in the earlier parts of the curves may in the first case be due to insufficient material. After 800 A. D. the correspondence is indeed remarkable. The curves are about equally pronounced. Marked maxima occur in both curves in the beginning of the tenth and eleventh centuries, during the fourteenth century, and from 1550 to 1750. A secondary maximum is common to both in the thirteenth century. Minima are common to both curves in the latter parts of the ninth, tenth, twelfth, thirteenth, fifteenth, and eighteenth centuries. The curves also show noteworthy differences, as the somewhat delayed appearance of the maxima in the dry curve, indicating slower reaction of the trees living in dry sites. Other differences are secondary maxima in the dry curve about 1130 and 1810 and in the wet curve 1080 to 1090, and 1890. Between 1 A. D. and 800 A. D. the curves do not show very good agreement, but present a great number of relatively small independent fluctuations. In common are a minimum during the third century, a secondary maximum about 370 and 380, as well as minima about 100, 500, 560 to 570, and 650 to 660.

The fluctuations in the earlier parts of the curves being very marked because of the scanty material, smoothed curves, calculated after the formula $\frac{a+2b+3c+2d+e}{9}$ and the resultant figure used for c, have been plotted above the actual growth curves. These smoothed curves show fairly good agreement from 700 to somewhat after 500 B. C., but after that they have rather independent courses. So have the unsmoothed curves from 200 B. C. to 1 A. D.

ALL FINALLY CORRECTED CURVES

A comparison of all finally corrected curves—that is, curves based upon trees in dry situations (curve 1, fig. 7), in moist situations (curve 2), in dry and moist situations (curve 3), in all kinds of situations (curve 4), and Huntington's (1914), fig. 38, and table G, p. 323, column F) curve (without the Caspian factor) based upon trees in all kinds of situations and obtained after a different method of correction (curve 5)—reveals the remarkable fact that they all agree in those parts that are computed from a very large quantity of material. Thus, the correspondence is particularly good, partly even detailed, since 800 A. D. All of the curves show maxima in the beginning of the tenth and eleventh centuries, during the fourteenth century, and since about 1550. They have minima in the latter parts of the tenth and twelfth centuries and about 1300 and 1500. During the eighteenth century the dry curve (curve 1) falls lower than the rest, and from 1770 to 1880 the wet curve (curve 2) is rather low. Since 1850 the dry curve remains low, while curves 2, 4, and 5 rise.

This writer has not extended the curves beyond 1000 B. C.; since only a few trees reach farther back and elimination of the factors of non-climatic nature therefore hardly can be made. The smoothed curves (curves 2, 3, and 4), from 1000 to 700 B. C., where largely computed from the same material, show good agreement with each other, but hardly any correspondence to Huntington's curve (curve 5), which has partly reversed course. From 700 to 500 B. C. all curves, including that of Huntington, agree rather well. Between 500 and 200 B. C., as mentioned, the maxima and minima in trees living in dry and moist situations occur at different times, giving all the curves different courses. Huntington's curve follows our curve 3 most closely. Not too much weight should be laid upon these earlier parts, for the material is too small for elimination of nonclimatic features, and satisfactory correction of them can not be made. To get around this last-mentioned difficulty, this writer has excluded the earliest parts of the trees, and this fact probably is the reason for some of the discrepancies between the writer's curves and that calculated by Huntington.

From about 200 B. C. to 800 A. D. all the curves present a great number of small fluctuations, and show neither marked similarities nor discrepancies. From 200 to 100 B. C., curves 1 and 5, however, are considerably low; and from 150 to 130 B. C. curve 4 also is very low.

The agreement between those parts of the curves that are calculated from a very large quantity of material is particularly significant, since different methods of correction and different age stages of the trees have been used to construct them. The agreements, consequently, are real, of external origin and almost certainly of climatic nature. This fact, together with conditions set forth on pages 125 to 132, signifies that the growth of the big tree, allowance made for eccentricity, effects of casualties, etc., is essentially determined by a combination of factors, and that the rôle played by each factor is subordinate and varying. The dependence of tree growth on the entire constellation of environmental conditions, not on individual conditions, is also emphasized by MacDougal (1924, p. 81) and Shreve (1924, p. 116).

The chief climatic factors influencing tree growth, as discussed on pages 125 to 132, appear to be precipitation, temperature, and sun radiation. The relative rôle of each factor is dependent on the time of its influence, upon other factors, upon internal conditions in the tree, upon earlier conditions in general, etc. Thus, growth can primarily follow now this, now that, factor. No direct study of the relationship has ever been made, so that not even the general laws are known. In the case of the big tree the importance of the individual factors is much more difficult to estimate, as data of temperature are entirely wanting. However, it appears to be certain that the sequoia curves do not specially record precipitation. High parts in the curves might directly or indirectly be connected with periods of heavy rainfall and low parts with scanty rainfall, because of the relationship between the different climatic factors as influenced by the activity of the sun, so that trees in moist and dry sites might be favored or checked contemporaneously

[1] Ernst Antevs, Quaternary climates, Publication No. 352 of the Carnegie Institution of Washington, pp. 115-153.

by different factors, but it can not be concluded that all high and low parts were connected with rainfall and drought. In this connection it is noteworthy that the tree-growth maximum during the fourteenth century coincides with an exceptional spottedness of the sun (Huntington and Visher, 1922, p. 109) and with the climatic stress, of which there are abundant historical records in the Old World, and which particularly expressed itself in unusually cold winters, cold rainy summers, and devastating storms.

Accordingly, before satisfactory interpretation of the sequoia curves and conclusions from them regarding the climate of the past can be made, it is necessary to have data on temperature, better knowledge of the relation between precipitation and growth of sequoia trees in dry situations, and general knowledge of the rôle for growth played by the radiation of the sun.

Besides being of climatological interest, the sequoia curve is of importance as eventually affording a possibility to extend the Swedish postglacial geochronology up to the present time. This chronology (not yet published), worked out by Ragnar Lidén (1911) in the valley of the River Ångermanälven (63° N.), is based upon annually laminated silty clays deposited in fiords of the Gulf of Bothnia ever since the disappearance of the last ice-sheet. The annual deposit consists of two thin layers, in texture and in color somewhat different, one of which may be essentially deposited in connection with the flood of the rivers during the melting of the snow in spring. By the upheaval of land, amounting to about 920 feet (280 meters), the clays have been gradually raised above sea-level and trenched by the rivers. Those from the last hundreds of years are not yet accessible, and Lidén has had to estimate the length of time that has elapsed since the formation of the youngest measured varve or annual layer.

This gap in the record might be bridged by help of the sequoia curve, for it seems likely that it will show a certain correspondence to the sedimentation curve in Norrland. The climatic stress during the fourteenth century, so distinctly recorded in the sequoia curve, is probably also recorded in the clay deposition. If this prove to be the case, and also other marked fluctuations in the tree curve are found in the clay curve, a connection may be made with high degree of probability, and the length of the postglacial time, which amounts to 8,500 to 9,000 years, exactly determined.

—*A. J. H.*

TORNADO IN SOUTHEASTERN ALABAMA

Mr. P. H. Smyth, meteorologist in charge of the Montgomery, Ala., Weather Bureau station, sends an account of a tornado which occurred in southeastern Alabama on October 25, 1925. This tornado was notable for being one of the most destructive storms of its kind that has occurred in southeastern Alabama, and also as being only the second tornado of record for October within the State.

It was clearly attendant upon the passage of a well-defined wind-shift line in the trough of low pressure connected with a depression the center of which passed northeastward over the Ohio Valley during the night of the 24th–25th, the tornado apparently having been first observed about 2:00 a. m.

The path was 75 to 80 miles long, beginning about 50 miles north of the Alabama-Florida line and extending ENE. to within about 10 miles of the Alabama-Georgia line. It was some 400 yards wide at its widest part.

The number of lives lost was reported to be 18; many persons were injured; property losses were estimated at a quarter of a million dollars.—*B. M. V.*

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, OCTOBER, 1925

[Reported by Señor J. B. Navarrete, El Salto Observatory, Santiago, Chile. Translated by B. M. V.]

In the month of October the period of atmospheric disturbances, starting in September, began to decline; rainfall diminished over the whole of the southern part of the continent.

Between the first and the third an important atmospheric depression lay over the southern region, causing bad weather with violent winds and rains between Coquimbo and Magellanes; the most important amounts of precipitation were 18 mm. at Valparaiso, 16 mm. at Talca, 19 mm. at Traiguen, 13 mm. at Valdivia and 14 mm. at Punta Arenas.

On the 4th, in the afternoon, an important V-shaped depression caused electrical storms accompanied by violent squalls and hail in the interior of Aconcagua, Santiago, and O'Higgins Provinces.

Between the 5th and the 10th a large anticyclonic area persisted, characterized by general good weather, with winds prevailingly southeast and rising temperature.

Between the 11th and the 13th a moderate depression caused variable weather and drizzling rain in the central zone.

From the 14th to the 22d a large anticyclonic area lay over the central part of the continent, causing steady atmospheric conditions. General fine weather was the rule during the period, with heavy south winds between Chiloe and Arauco and high temperatures over the whole central zone of Chile.

During the 23d and the 24th a depression of some intensity lay over the southern area, causing rains between Valdivia and Magellanes; at Valdivia 11 mm. fell.

Between the 26th and the 28th another cyclonic depression, more important than the previous one, affected the whole southern region of the continent; on this occasion rain and wind storms occurred from Valdivia southward. On the island of Huafo the wind velocity reached 25 m/s. (56 m/h.).

During the last days of the month atmospheric pressure rose over the southern part of the continent, reestablishing the anticyclonic régime, with general fine weather and rise of temperature.

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING OCTOBER, 1925

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements the reader is referred to the REVIEW for January, 1924, **52** : 42 and January, 1925, **53** : 29.

From Table 1 it is seen that solar radiation intensities average above the normal for October at all three stations. This is attributable, at least in part, to the prevailing low temperatures and the resulting low vapor pressures. At Washington the vapor pressure averaged only about 64 per cent of the October normal, and at Madison and Lincoln about 75 per cent.

A noon radiation intensity of 1.51 gram calories per minute per cm.^{2} obtained at Lincoln on the 28th is within 1 per cent of the highest radiation intensity ever measured at that station in October.

Table 2 shows that the solar and sky radiation received on a horizontal surface averaged decidedly below the normal for October at all three stations. The deficiency was due to the excessive cloudiness, which averaged about 160 per cent of the October normal at Washington and Lincoln and 140 per cent at Madison.

At Washington skylight polarization measurements made on six days give a mean of 64 per cent, with a maximum of 71 per cent on the 7th. At Madison, measurements made on three days give a mean of 60 per cent with a maximum of 67 per cent on the 10th. The values for Washington are above the October averages, and those for Madison are slightly below.

TABLE 1.—*Solar radiation intensities during October, 1925*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Oct. 7	7.29	------	0.67	0.83	1.09	1.44	1.22	1.14	1.02	0.91	7.04
8	6.50	------	------	------	0.98	------	------	------	------	------	6.27
10	2.74	------	1.04	1.20	1.37	1.56	------	------	------	------	2.62
20	3.30	0.53	0.99	1.15	1.33	1.53	------	------	------	------	2.87
21	4.17	0.78	0.88	1.00	1.21	------	------	------	------	------	3.00
23	4.75	------	------	------	1.03	------	------	------	------	------	3.99
29	2.36	0.77	0.92	1.03	1.21	1.35	------	------	------	------	2.36
31	3.81	0.70	0.84	1.03	1.23	1.49	------	1.05	0.92	0.83	3.15
Means	------	0.77	0.89	1.04	1.18	1.47	(1.23)	(1.10)	(0.97)	(0.87)	------
Departures	------	−0.01	+0.04	+0.09	+0.07	+0.01	+0.11	+0.17	+0.17	+0.17	------

Madison, Wis.

Oct. 10	3.00	1.01	1.09	1.19	1.29	1.40	------	------	------	------	3.45
17	3.00	0.94	1.05	------	1.31	1.48	------	------	------	------	3.15
30	2.06	------	------	------	------	------	------	1.19	------	------	1.96
31	1.78	0.67	0.86	0.98	1.19	1.41	------	------	------	------	3.15
Means	------	0.87	1.00	(1.05)	1.26	1.43	------	(1.19)	------	------	------
Departures	------	+0.13	+0.07	+0.03	+0.07	+0.05	------	+0.17	------	------	------

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during October, 1925*

Lincoln, Nebr.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Oct. 9	3.81	------	------	1.15	1.35	------	1.38	1.24	1.15	1.04	2.87
14	6.50	------	------	------	------	1.53	1.36	1.21	1.07	0.96	4.95
15	4.95	0.76	0.91	1.09	1.31	1.53	1.28	1.10	0.94	0.78	4.75
19	3.00	1.00	1.14	1.27	1.42	1.60	1.42	1.27	1.14	1.04	2.49
20	3.15	------	0.98	1.16	1.39	1.56	1.40	1.25	1.12	0.99	2.26
22	4.75	------	0.92	1.06	1.21	------	------	------	------	------	5.36
26	3.30	------	------	------	------	------	------	------	1.10	1.04	2.62
28	1.24	1.02	1.16	1.34	1.48	1.68	1.46	1.18	------	------	1.52
30	1.37	------	------	------	1.34	------	1.33	1.13	1.03	0.91	2.87
31	3.00	------	0.85	1.08	------	------	------	------	------	------	3.81
Means	------	0.93	0.99	1.16	1.36	1.58	1.39	1.20	1.08	0.97	------
Departures	------	+0.03	+0.03	+0.05	+0.07	+0.05	+0.12	+0.11	+0.12	+0.12	------

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation: Washington	Madison	Lincoln	Chicago	New York	Average daily departure from normal: Washington	Madison	Lincoln
1925	cal.	cal.	cal.	cal.	cal.	cal	cal.	cal.
Oct. 1	248	190	178	157	213	−86	−94	−174
8	182	197	246	127	211	−125	−39	−78
15	223	182	337	166	182	−64	−47	+43
22	194	144	219	128	135	−70	−62	−45
Deficiency since first of year on Oct. 28						−812	−189	−2,499

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure and departure for the month, as well as the highest and lowest barometer reading at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., seventy-fifth meridian time, and the departures are only approximate, as the normals were taken from the Pilot Chart and are based on Greenwich mean noon observations, which correspond to those taken at 7 a. m. seventy-fifth meridian time.

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	Inches	Inches		Inches	
St. Johns, Newfoundland	29.65	−0.27	30.16	3d	29.12	9th
Nantucket	29.94	−0.08	30.46	30th	29.30	10th
Hatteras	30.01	−0.02	30.38	11th	29.64	5th
Key West	29.99	+0.01	30.12	12th	29.94	[1] 4th
New Orleans	30.02	+0.01	30.26	[1] 10th	29.84	16th
Swan Island	29.87	−0.04	29.94	[1] 12th	29.80	[1] 4th
Turks Island	30.01	+0.06	30.08	[1] 12th	29.90	5th
Bermuda	30.08	+0.05	30.26	2d	29.82	10th
Horta, Azores	29.96	−0.14	30.38	27th	29.58	19th
Lerwick, Shetland Islands	29.74	−0.05	30.30	7th	28.61	23d
Valencia, Ireland	29.85	−0.06	30.52	[1] 1st	28.67	22d
London	29.93	+0.02	30.46	2d	28.86	23d

[1] And on other dates.

While the average pressure for the month was not far from the normal at the last three stations given, the averages for the three decades differed materially. At Lerwick the average for the 1st decade was 30.18 inches, for the second, 29.87 inches; and for the last 11 days; 29.24 inches. At Valentia the figures for the same periods are as follows: 30.40 inches, 29.95 inches, and 29.24 inches, respectively.

Taken as a whole, this was undoubtedly one of the stormiest Octobers on record over the North Atlantic. The number of days with winds of gale force was not only much above the normal as shown on the Pilot Chart, but three of the disturbances were of exceptional severity, and the greater part of the ocean was visited by heavy weather at one time or other during the month, although comparatively moderate weather prevailed over the eastern section of the steamer lanes until the 17th. Over 150 vessels rendered storm reports, but, due to lack of space, it is impossible to give but a small portion of them in the table.

As is often the case during an unusually stormy month, the number of days with fog was much below the normal shown on the Pilot Chart. This was especially true over the Grand Banks, where fog was reported on from three to four days only, while off the coasts of America and northern Europe the frequency was about the same.

On the 1st there was a shallow depression near 35° N., 48° W., that moved rapidly northward, the center on the 2d being near 46° N., 45° W., and on the 3d near 50° N., 40° W. On the 2d, moderate to strong gales prevailed over the region between the fortieth and forty-fifth parallels and the forty-fifth and fifty-fifth meridians, while on the 3d the storm area extended from the forty-fifth to fifty-fifth parallels and thirty-fifth to forty-fifth meridians.

On the 4th there was a LOW over Nova Scotia that moved rapidly northeastward and on the 5th was central near Belle Isle, where it remained nearly stationary until the 7th.

On the 8th there were two LOWS over the ocean; the first central near 40° N., 55° W., and the second over the Azores. By the 9th the two disturbances had apparently joined, being central near 47° N., 55° W. On the 9th there was also a depression near Hatteras that afterwards developed into one of the severest storms of the month. On the 8th gales were reported from a limited area between the Bermudas and Newfoundland, and also in the vicinity of the Azores, while by the 9th the storm area had increased, covering the western section of the steamer lanes. On the 9th unusually strong winds were encountered in the Gulf of Mexico, as shown by the report in table from the American S. S. *Alabama*.

Charts VIII and IX show the conditions on the 10th and 11th, respectively. On the 10th the two areas of low pressure were responsible for exceptionally severe weather over the western half of the ocean, while by the 11th the storm area had contracted in extent, the eastern LOW having apparently filled in. On the 11th strong winds were again reported from the Gulf of Mexico, as shown by report from American S. S. *Gulfcoast*. On the 12th the northwestern disturbance was central near Belle Isle, and northwesterly gales still prevailed between the thirty-fifth parallel and Newfoundland, west of the fiftieth meridian. According to press report heavy marine casualties were due to this storm, especially among small craft.

On the 13th and 14th comparatively moderate weather prevailed over the entire ocean. On the 15th Father Point was near the center of a LOW that increased in intensity as it moved slowly eastward. On the 17th there was a secondary LOW near 36° N., 40° W., that afterwards apparently joined with the main depression, which continued to deepen, reaching its greatest intensity on the 19th, when barometric readings of less than 28 inches were reported.

Charts X to XIII show the conditions from the 19th to 22d, inclusive.

On the 23d the center of the disturbance was off the coast of Great Britain and the eastern section of the steamer lanes was still swept by westerly gales of hurricane force. This storm caused a great deal of damage to shipping, and captains of liners were reported to have said that it was the worst of their experience. On the 23d there was a second disturbance central near Sable Island, with strong gales between the thirty-fifth and forty-fifth parallels, west of the fifty-fifth meridian. On the 24th the western LOW was central near Belle Isle, and the eastern off the north coast of Scotland, while both of the storm areas had decreased in intensity and extent. On the 25th New York was near the center of another LOW that was responsible for strong southwesterly gales along the American coast, between Nantucket and Hatteras, and storm reports were also received from vessels in mid-ocean while comparatively quiet weather prevailed off the European coast.

On the 26th the western LOW was central near Father Point, and westerly winds of gale force prevailed between Nova Scotia and Nantucket. The eastern disturbance apparently took on a new lease of life on the 26th, as on that date westerly gales were again encountered east of the thirtieth meridian. The western LOW moved steadily eastward and on the 28th was central near 55° N., 35° W. On both the 27th and 28th storm reports were received from all parts of the steamer lanes, although there was no well-defined storm area. This disturbance increased rapidly in intensity and extent, and on the 29th the center was off the coast of Ireland, while strong westerly gales swept the ocean east of the fortieth meridian, the storm area extending as far south as the Azores. On the 29th there was another depression over Nova Scotia, with southerly gales in the easterly quadrants. On the 30th the conditions over the eastern section did not differ materially from those of the previous day; off the coast of Georgia strong northeasterly winds prevailed, accompanied by comparatively high barometric readings.

On the 31st westerly gales of hurricane force prevailed between the fortieth and fiftieth parallels and thirtieth and fiftieth meridians, and northeasterly gales along the American coast between Nantucket and Hatteras. On the same date there was also a depression in the Gulf of Mexico, accompanied by winds of gale force.

Waterspouts during the month were reported as follows:

American S. S. *Coldwater*, Capt. A. C. Forward; observer, H. Olesen, Charleston to Bremen:

At 3 p. m., October 5, in 40° 36′ N., 57° 28′ W., observed immense waterspout.

British S. S. *Muneric*, Capt. Wm. Hare; observer, R. McAuslan, New Orleans to Frontera:

At 9.30 a. m., October 10, in 24° 15′ N., 90° 42′ W., passed close to well-formed waterspout.

Weather Bureau office, Corpus Christi, Tex., Mr. J. P. McAuliffe in charge:

On October 9, between 11 and 11.50 a. m., four waterspouts were observed in the vicinity of Corpus Christi. Three formed over Corpus Christi Bay, the fourth over Nueces Bay. The largest of the waterspouts first appeared about 3 miles off shore and traveled rapidly in a southwesterly direction, breaking up upon striking the land.

Mr. McAuliffe states that the atmosphere was unusually oppressive at the time, but that a norther occured soon afterwards.

Ocean gales and storms, October, 1925

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gales ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′									
Westpool, Am. S. S.	Norfolk	Bremen	41 51 N.	52 28 W.	Sept. 30	Noon, 1st.	2d.	29.72	NNE.	NE., 9.	N.	NE., 10.	NE.-NNE
Chicago, Fr. S. S.	Bordeaux	New York	46 41 N.	41 50 W.	Oct. 2.	1 a. 2d.	3d.	29.60	S.	SSW., 9.	WNW.	NW., 9.	SSW.-W.
Olterra, Br. S. S.	Rouen	Philadelphia	41 22 N.	59 56 W.	4th.	4 p., 4th.	4th.	29.72	S.	S., 10.	SW.	S., 10.	S.-SSW.
Verbania, Br. S. S.	London	New York	41 43 N.	60 30 W.	6th.	8 p., 7th.	8th.	29.65	S.	W., 9.	NNW.	W., 10.	SW.-W.-WNW.
West Celeron, Am. S. S.	Alexandria	New Orleans	32 33 N.	27 25 W.	7th.	1 p., 8th.	8th.	29.81	SW.	SW., 8.	WSW.	SW., 8.	SW.-WSW.
Alabama, Am. S. S.	Marcus Hook	Port Neches, Tex.	27 43 N.	90 16 W.	9th.	8 p., 9th.	10th.	30.00	N.	N., 4.	NNE.	NNE., 8.	
Antinous, Am. S. S.	Mobile	Bremen	41 40 N.	51 30 W.	8th.	5 a., 9th.	11th.	29.48	WSW.	NW., 8.	W.	—, 10.	Steady.
Chile Maru, Jap. S. S.	Lisbon	New York	40 10 N.	71 58 W.	10th.	8 a. 10th.	11th.	29.45	NW.	NW., 11.	NW.	NW., 11.	Do.
Elbergen, Du. S. S.	Swansea	Montreal	52 25 N.	52 45 W.	10th.	1 a., 10th.	10th.	29.25	NNW.	NNW., 7.	NNW.	NNW., 11.	Do.
Hoxie, Am. S. S.	Avonmouth	Baltimore	42 40 N.	55 10 W.	11th.	3 a., 11th.	13th.	29.40	W.	W., 9.	NW.	NW., 10.	Do.
Gulfcoast, Am. S. S.	Providence	Port Arthur	24 40 N.	83 40 W.	11th.	6 p., 11th.	11th.	30.07	N.	NE., 8.	NE.	NE., 8.	NE.-E.
Spar, Du. S. S.	Galveston	Bremen	44 58 N.	41 30 W.	17th.	10 p., 17th.	18th.	28.96	NW.	NW., 11.	W.	NW., 12.	NW.-NNW.
Winnebago, Br. S. S.	Brunswick,	London	43 44 N.	38 42 W.	15th.	8 p., 18th.	23d.	28.83	SE.	SSW., 7.	NNW.	NW., 10.	SSW.-WNW.
Stockholm, Swed. S. S.	New York	Gothenburg	54 38 N.	33 30 W.	18th.	18th.	20th.	28.00	NW.	ESE., 9.	SE.	ESE., 10.	ENE.-ESE.
Coelieda, Am. S. S.	do	Manchester	47 35 N.	35 50 W.	17th.	7 a., 19th.	20th.	28.53	W.	WSW., 10.	WSW.	WSW., 10.	WSW.-W.
Verentia, Br. S. S.	London	Montreal	53 37 N.	38 25 W.	19th.	1 p., 19th.	20th.	27.95	S.	S., 10.	NE.	—, 10.	S.-SSW.
Hellig Olav, Dan. S. S.	New York	Christiansand.	50 06 N.	42 20 W.	18th.	6 a., 20th.	20th.	28.49	WNW.	NW., 9.	NW.	WNW, 10.	Steady.
Blommersdijk, Du. S. S.	Rotterdam	Philadelphia	48 21 N.	30 04 W.	18th.	9 a., 20th.	23d.	28.61	SSE.	W., 9.	NW.	W., 11.	SW.-WNW.
Pres. Harding, Am. S. S.	Queenstown	New York	49 31 N.	38 31 W.	21st.	Noon, 21st.	23d.	28.98	WSW.	W., —.	E.	W., 10.	Steady.
War Pathan, Br. S. S.	Glasgow	Port of Spain	46 53 N.	21 06 W.	20th.	Noon, 21st.	23d.	28.91	SW.	W., 9.	W.	NW., 11.	SW.-W.
Alban, Br. S. S.	Norfolk	Para	35 28 N.	74 17 W.	22d.	1 p., 22d.	22d.	29.51	SW.	WSW., 8.	WNW.	WSW., 10.	SW.-WSW.
Eastern Victor, Am. S. S.	Rotterdam	Philadelphia	46 10 N.	14 25 W.	19th.	6 p., 22d.	24th.	28.76	SSW.	SSW., 9.	NW.	WNW., 12.	S.-WSW-WNW
Columbus, Ger. S. S.	Cherbourg	New York	42 36 N.	60 23 W.	23d.	4 p., 23d.	24th.	29.26	SE.	WSW., 10.	WNW.	WSW., 11.	SE.-S.-WNW.
Leonardo da Vinci, Ital. S. S.	Genoa	do	40 39 N.	63 28 W.	26th.	11 p., 25th.	26th.	29.51	SE.	SW., —.	WSW.	—, 11.	
Manchester Merchant, Br. S. S.	Manchester	St. John, N.B.	49 48 N.	33 58 W.	24th.	6 p., 25th.	26th.	29.03	WSW.	W., 11.	NNW.	W., 11.	W.-NW.
Arundo, Du. S. S.	Rosario	Ireland	48 55 N.	12 01 W.	26th.	8 p., 26th.	27th.	29.38	NW.	SW., 9.	WNW.	WSW., 10.	SW.-W.
Manchester Merchant, Br. S. S.	Manchester	St. John, N.B.	48 35 N.	40 07 W.	27th.	Noon 28th	29th.	29.39	WSW.	W., 8.	WNW.	W., 12.	W.-WNW.
Mercier, Belg. S. S.	Antwerp	New York	49 35 N.	27 20 W.	28th.	10 p., 28th.	30th.	28.81	SW.	SW., 10.	NW.	NW., 12.	SW.-W.-NW.
Dania, Dan. S. S.	Newcastle	Boston	51 35 N.	37 13 W.	29th.	7 a., 29th.	29th.	29.43	N.	N., 10.	N.	N., 10.	
Mercier, Belg. S. S.	Antwerp	New York	48 42 N.	34 16 W.	30th.	11 p., 30th	Nov. 1st	28.85	W.	WSW., 11.	NW.	W., 12.	W.-NW.
Baja California, Am. S. S.	Vera Cruz	New Orleans	20 40 N.	95 03 W.	30th.	4 a., 31st.	Oct. 31	29.83	N.	N., 8.	NE.	N., 8.	Steady.
Wellfield, Br. S. S.	England	New York	50 20 N.	42 00 W.	28th.	2 p., 31st.	31st.	28.44	W.	NW., 11.	N.	NW., 11.	Do.
NORTH PACIFIC OCEAN													
Pres. McKinley, Am. S. S.	Seattle	Yokohama	50 23 N.	179 13 W.	1st.	8 a.	1st.	29.36	NNW.	NNW., 8.	NNW.	NNW., 8.	Steady.
Do	do	do	44 34 N.	153 05 E.	4th.	3 a.	4th.	29.38	NE.	NE., 7.	N.	NE., 9.	NE.-N.
Montgomery City, Am. S. S.	Shanghai	Port Townsend.	38 47 N.	135 45 E.	2d.	9 a., 2d.	3d.	29.61	NE.	NE.—.	NNW.	NNE., 8.	NNE.-N.
Shabonee, Br. S. S.	do	San Pedro	41 50 N.	176 E.	2d.		4th.	28.87	SE.	N. 10.	N.	N., 10.	
Levant Arrow, Am. S. S.	do	San Francisco	36 N.	132 34 E.	2d.	3 p., 2d.	3d.	29.78	NW.	NW., 10.	NNE.	NW., 10.	NW.-N.-NNE.
West Sequana, Am. S. S.	Manila	do	44 30 N.	168 W.	2d.	4 a., 3d.	4th.	29.16	SE.	S.	W.	SW., 11.	SE.-SW.
Hokkai Maru, Jap S. S.	Grays Harbor	Yokohama	46 10 N.	159 32 E	3d.	4 p, 3d.	5th.	29.46	WSW.	NE.	NNW.	—, 9.	1 point.
West Jena, Am S. S.	Kobe	Portland	36 40 N.	145 55 E	3d.	4 p, 3d.	5th.	29.62	NW.	S. 4.	NNE.	N., 11.	S.-SW.-W.-NW.
Pres. Grant, Am S. S.	Yokohama	Seattle	50 N.	164 43 W.	3d.	2 a, 4th.	5th.	29.17	N.	NW., 9.	W.	NW., 10.	N.-W.
Gulfqueen, Am S. S.	New York	San Pedro	27 30 N.	115 30 W.	4th.	2 a, 5th.	5th.	29.50	SE.	S., 9.	WSW.	S., 10.	
Iyo Maru, Jap S. S.	Yokohama	Victoria	41 45 N.	153 40 W.	4th.	2 p, 4th.	5th.	29.18	N.	NNW.	N.	N., 10.	SW.-N.
Akibasan Maru, Jap S. S.	Grays Harbor	Yokohama	51 06 N.	170 30 W.	3d.	2 p, 5th.	7th.	28.81	SE.	SW.	WNW.	N., 10.	
Gulfqueen, Am S. S.	San Pedro	Port Arthur, Tex.	20 18 N.	106 38 W.	12th.	5 a.	12th.	29.87	SE.	SE., 7.	E.	SE., 8.	E.
Java Arrow, Am. S. S.	Shanghai	San Francisco	48 26 N.	170 28 W.	11th.	4 a., 12th.	14th.	29.22	SE.	SW., 5.	SSW.	W., 8.	SSE. W.
Victoria, Am. S. S.	Nome	Seattle	58 N.	167 W.	14th.		14th.	29.33	NE.	NE., 8.	NE.	NE., 8.	Steady.
West Jena, Am. S. S.	Kobe	Portland	50 30 N.	157 40 W.	12th.	8 p., 13th.	15th.	29.01	E.	E., 10.	ESE.	E., 10.	E.-SE.
Tenpaisan Maru, Jap. S. S.	Japan	do	49 30 N.	162 W.	12th.	4 p., 14th.	16th.	28.12	E.	E., 8.	SW.	—, 9.	ENE.-WNW.
Unkai Maru, Jap. S. S.	Muroran	do	51 46 N.	160 11 W.	13th.	noon, 15th.	16th.	28.53	ENE.	NE., 7.	SSE.	NE., 11.	E.
Montgomery City, Am. S. S.	Shanghai	Port Townsend.	50 29 N.	144 55 W.	15th.	6 a.	15th.	28.95	ESE.	SE., 11.	SSW.	SE., 11.	ESE.-SSE.
West O'Rowa, Am. S. S.	Yokohama	Portland	45 54 N.	165 51 E.	15th.	6 a., 16th.	18th.	29.30	W.	W., 9.	WNW.	W., 9.	W.-NW.-N.
Montgomery City, Am. S. S.	Shanghai	Port Townsend.	49 35 N.	135 50 W.	16th.	4 a., 17th.	17th.	29.18	ESE.	SE., 12.	S.	SE., 12.	SE.-S.
Salina, Am. S. S.	Cebu	Portland	41 10 N.	152 55 W.	18th.	6 a.	18th.	29.27	SE.	SSW., 9.	WSW.	SW., 11.	SSW.-SW.
Emp. of Australia, Br. S. S.	Yokohama	Victoria	50 20 N.	142 30 W.	18th.	8 p., 18th.	19th.	29.17	SSE.	S., 7.	SW.	SW., 9.	S.
Akagisan Maru, Jap. S. S.	do	San Francisco	39 30 N.	149 E.	18th.	5 a., 19th.	19th.	29.16		SSE., 7.	WSW.	—, 10.	SSE.-S.-WSW.
Do	do	do	46 05 N.	171 50 E.	23d.	5 a., 24th.	24th.	29.68		SW., 6.	WSW.	—, 9.	Do.
Eldridge, Am. S. S.	do	Seattle	49 35 N.	174 26 W.	21st.	noon, 21st.	23d.		NNE.	NNE., 5.	NE.	NE., 12.	NNE.-NE.
West Jester, Am. S. S.	Manila	San Francisco	43 50 N.	167 25 W.	21st.	10 p., 21st.	24th.	28.75	NNE.	NNE., 11.	SE.	NNE., 11.	NNE.-NE.-E.
Pres. Grant, Am. S. S.	Seattle	Yokohama	52 08 N.	164 08 W.	22d.	6p., 22d.	23d.		NE.	NE., 9.	NE.	NE., 10.	Steady.
Shidzuoka Maru, Jap. S. S.	Yokohama	Victoria	48 51 N.	161 12 W.	26th.	6 a., 27th.	28th.	28.93	SW.	S., 9.	SW.	S., 10.	SSE.-S.-SSW.
Akagisan Maru, Jap. S. S.	do	San Francisco	47 50 N.	167 50 W.	26th.	8 a., 26th.	28th.	28.98		SSE., 9.	WSW.	—, 9.	SSE.-S.-WSW.
Havre Maru, Jap. S. S.	Wakamatsu	Coos Bay	46 52 N.	170 12 E.	27th.	noon, 27th.	28th.	29.55	SE.	SE., 8.	WSW.	S., 11.	SE.-WSW.
Pres. Jackson, Am. S. S.	Yokohama	Victoria	49 10 N.	178 22 W.	27th.	9 p., 27th.	29th.	27.93	S.	NW., 9.	W.	W., 10.	
Crosskeys, Am. S. S.	Tsingtao	Seattle	47 N.	159 40 E.	29th.	2 p., 29th.	30th.		WNW.	WNW., 8.	WNW.	WNW., 8.	Steady.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

So far in 1925 there have been two stormy months over the upper reaches of the North Pacific Ocean. The first was February, with several days during which whole gales to hurricane winds occurred. The second was October with 13 days on which equally violent winds are known to have been experienced. This is extraordinary for so early a period in the stormy season.

A fairly strong cyclonic development lay over the central Aleutians at the beginning of the month. It had intensified considerably by the 3d, and on the 3d, 4th, and 5th gales of force 10 to 11 occurred from the fortieth parallel northward to the archipelago. Storm winds also prevailed east of Hondo on the 3d, and gales of force 8 to 10 over eastern and western Japanese waters on the 2d to 4th. By the 9th the LOW over the Aleutians had lost practically all its energy, and not until the 12th were there signs of its renewed activity.

At this time low pressure rapidly overspread a great area in middle and northern latitudes, and by the 15th was existent from 155° E. to 130° W., with barometer readings almost down to 28 inches near 49° N., 160° W., and gales of force 11 occurring near this center and to the eastward as far as the one hundred and forty-fifth meridian. On the 17th the main force of the storm, the center of which was now over the Alaska Peninsula, lay in the eastern semicircle, where a SE. hurricane was in progress at and near 49° 35′ N., 135° 50′ W. By the 20th this LOW had ceased to be of importance, but on the 21st another energetic cyclone was forming rapidly near 40° N., 165° W. Two days later a LOW appeared near 45° N., 170° E. The two joined on the 27th, and whole gales to storm winds again swept the central longitudes of the northern steamer routes. This disturbance had abated by the close of the month.

The number of days in this region with pressures lower than 29 inches was at least 12. The minimum reading reported was 27.93 inches, made on board the American steamer *President Jackson*, in 49° 10′ N., 178° 22′ W., on the 27th, maximum wind, 10 west.

For the first time in many months the North Pacific HIGH was greatly disturbed by cyclonic influences, and during much of the second decade of October it was little more than an anticyclonic ridge off the coast of the United States. During the other two decades it was fairly well developed, but was not at its full normal condition until the last four days of the month, when it covered middle latitudes east of the one hundred and eightieth meridian.

The following table shows the atmospheric pressures for several island and coast stations. It will be observed from the departures given that the Aleutian LOW was considerably more active than usual over the region to the southwest of Alaska, but less active over that part of the Gulf of Alaska east of Kodiak:

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
Dutch Harbor [1] [2]	29.34	−0.35	30.26	22d	28.58	27th
Saint Paul [1]	29.50	−0.16	30.56	22d	28.78	27th
Kodiak [1]	29.59	0.00	30.16	23d	28.76	15th
Midway Island [1]	30.02	−0.03	30.12	10th	29.86	24th
Honolulu [1]	29.97	−0.03	30.08	16th	29.81	21st
Juneau [1]	30.00	+0.13	30.32	25th	29.47	19th
Tatoosh Island [3] [4]	30.08	+0.06	30.40	19th	29.61	5th
San Francisco [3] [4]	29.96	−0.04	30.15	27th	29.67	5th
San Diego [3] [4]	29.94	+0.01	30.08	27th	29.60	5th

[1] P. m. observations only.
[2] 23 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.

East winds continued to prevail at Honolulu, but there was a fair sprinkling of kona winds as the northern LOWS dipped southward. The maximum velocity was 26 miles an hour from the east, on the 6th. Rainfall was above the normal for the first time in any month this year. There was a total of 2.47 inches, giving a departure of 0.92 inch.

The only gales reported from the Far East that might be of tropical origin were some of moderate force that occurred south of Japan on the 13th. There were some storm conditions, however, as may be noted in the accompanying typhoon report by the Rev. José Coronas, S. J., of the Manila Observatory.

In American tropical waters moderately severe gales were experienced on the 4th and 5th by vessels to the westward of Lower California. The American steamer *Gulfqueen* encountered a south gale, force 10, in 27° 30′ N., 115° 30′ W., barometer 29.50 inches, early on the 5th. On the 12th this steamer, proceeding southward, fell in with rough weather near 20° N., 105° W. The British steamer *Canadian Seigneur* experienced similar weather near by. No barometric disturbance was noted by either vessel on this date. The winds were SSE. to E., highest force 8.

On the 22d to 25th occurred what was perhaps the most violent disturbance of the month in these waters. Mr. E. Vasquez, observer and chief officer of the Mexican steamer *Sinaloa*, has drawn for us a tentative track of this storm, which he finds central in 13° 30′ N., 96° W., at 5 p. m. of the 22d, having originated not far from that position. He shows the cyclone to have moved WNW. until the 24th, when, at 6 a. m., it was central in 16° 20′ N., 104° 30′ W. During that day its course must have curved rapidly through NW. into N. It crossed Cape Corrientes during the night and passed inland. Press reports for the 25th speak of a "terrific hurricane lashing the coast towns," damaging many houses and leveling trees on the mountain slopes. The American steamer *Corinto* mentions encountering a SSE. gale, force 8, pressure 29.90, in 19° 04′ N., 104° 20′ W., on this date.

Fog, as in October of last year, was comparatively infrequent over the northern part of the ocean, although over the southern part of the Gulf of Alaska it was reported on six days, and on the Washington and Oregon coasts it occurred on 30 per cent to 40 per cent of the days. It was reported on one day south of the thirtieth parallel, that being the 18th, in 28° N., 145° W.

ONLY ONE SHALLOW DEPRESSION AND ONE SMALL, BUT INTENSE, TYPHOON OVER THE PHILIPPINES IN OCTOBER, 1925

By REV. JOSÉ CORONAS, S. J.

[Weather Bureau, Manila, P. I.]

On the 5th a shallow depression appeared to the east of Mindanao in about 130° longitude E. and 8° latitude N. It moved northwestward across the Visayas and Mindoro on the 6th and 7th; and on the 8th it recurved northeastward about 200 miles to the west of Luzon. On the 9th it moved again into the Pacific near the northern coast of Luzon, moving eastward.

After the preceding depression a low-pressure area remained for several days over the China Sea near Luzon, and even over Luzon, until on the 13th a small but severe typhoon appeared over the China Sea northwest of Palawan Island between 117° and 118° longitude E., 11° and 12° latitude N. It moved ENE. and was felt as a vio-

lent storm in Culion on the 15th and San Jose, Mindoro during the night of the 15th and 16th. The steamer *Perlak* was in the center of this typhoon only about 9 miles to the W. of south Mindoro, the barometer having fallen at midnight of the 15th to 28.14 inches (714.75 mm.). We have no observations from midnight to 8 a. m. of the 16th, as the barometer with which the observations were made was lost in the storm. But as it was about or not far from 1 a. m. when the vortical calm was observed, we suppose that the barometric minimum was still lower. During the calm the stars could be seen and many birds fell on the ship.

The small typhoon lost much of its energy on striking Mindoro and filled up within the Philippines on the 17th between 13° and 14° latitude N. and near 123° longitude E.

Besides the Philippine depression and typhoon mentioned another typhoon was shown by our weather maps at 6 a. m. of October 1 to the SE. of Tokio in about 141° 30′ longitude E., 33° 35′ latitude N., moving ENE. The steamer *President Adams* was near the center with a barometric minimum of 29.03 inches (737.35 mm.) at 5 a. m. of October 1. This was the same typhoon mentioned in our article for last month as situated on the 25th of September between Guam and the Philippines moving WNW. On the 26th it took a northerly direction until it recurved to ENE. on the 30th. The steamer *Radnor* met this typhoon to the east of the Loochoos with a barometric minimum of 29.27 inches (743.44 mm.) at 6 a. m. of September 28.

The approximate positions of the center at 6 a. m. of September 24 to 30 were as follows:

24th, 6 a. m., 142° 10′ long. E., 11° 00′ lat. N.
25th, 6 a. m., 137° 00′ long. E., 13° 40′ lat. N.
26th, 6 a. m., 132° 15′ long. E., 15° 45′ lat. N.
27th, 6 a. m., 130° 50′ long. E., 19° 15′ lat. N.
28th, 6 a. m., 132° 00′ long. E., 23° 10′ lat. N.
29th, 6 a. m., 132° 20′ long. E., 27° 50′ lat. N.
30th, 6 a. m., 133° 40′ long. E., 31° 20′ lat. N.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The current month was the first of 1925 having a temperature considerably below the normal. Three anticyclones, each of more than the usual intensity for October, brought unseasonably low temperature to the upper Missouri Valley and the northern Plains States. These anticyclones were well distributed throughout the month, one each occurring in the first, second, and third decades, respectively. Concomitant features were an increase in the number and intensity of cyclonic storms and fairly abundant rainfall in the Rocky Mountain and Plateau regions, the Gulf and southeastern States. The usual details follow.—*A. J. H.*

CYCLONES AND ANTICYCLONES

By W. P. DAY

The number of low-pressure areas during October was decidedly above the normal. The paths of 23 of these have been plotted on Chart II, a number not often exceeded during a winter month. The storm areas at times followed each other in close succession with but slight intervals of rising pressure between.

High-pressure areas were rather less than the normal in number; 11 which could be definitely traced were plotted on Chart I. Of the three important HIGHS, two were well shown at Fort Simpson, Canada, before reaching the United States. The one which appeared in the Northwest on the 18th, however, was not definitely heralded at Fort Simpson.

FREE-AIR SUMMARY

By L. T. SAMUELS

The large negative temperature departures occurring at certain stations present the most outstanding feature in the average free-air conditions for the month. It is evident from Table 1 that these departures are greatest and of practically equal magnitude at the three northernmost stations, somewhat smaller at Broken Arrow and least at Groesbeck and Due West, the southern and easternmost stations, being practically negligible at the latter place. At the northern stations they remain exceedingly large to the upper limit of the observations which at Ellendale was 5,000 m., while at Broken Arrow and Groesbeck the usual decrease with altitude occurs. The constancy of the abnormally low temperatures throughout the month at the northern stations is well brought out in the following table by the high percentages of days (i. e., of those on which kite flights were made) having temperatures below normal.

Station	Surface	Meters above sea level				
		1,000	2,000	3,000	4,000	5,000
Ellendale	90	97	97	84	83	100
Drexel	96	92	81	69	75	------
Royal Center	90	88	89	83	------	------
Broken Arrow	67	63	50	50	50	------
Groesbeck	52	58	17	33	33	------
Due West	46	44	33	33	------	------

Another feature was the abnormally high winds which prevailed at various altitudes in the latter half of the month during which period two pronounced anticyclones passed over the greater portion of the country. The strong winds were not confined to the regions above these HIGHS, however, but prevailed in general over the intervening LOWS as well. Some of the highest velocities recorded during this period are shown below.

Station	Date	Velocity	Direction	Altitude
		M. p. s.		*M.*
Broken Arrow	19	40	W.	6,000
Denver	25	36	WNW.	4,600
Drexel	28	41	WNW.	5,800
Due West	27	36	WSW.	6,000
Do.	28	39	WSW.	7,000
Ellendale	16	40	W.	8,000
Do.	31	39	WNW.	6,300

The pronounced anticyclone which prevailed at the end of the month was accompanied by record minimum temperatures for October for various altitudes at all aerological stations. As would be expected with such marked deficiencies in the monthly mean temperatures, the average relative humidities were above normal while the vapor pressures were mostly below.

The resultant winds for the month, in keeping with the large negative temperature departures, show unusually pronounced deviations from their normals. In table 2 it will be noted that the normal resultant at Drexel contains an appreciable south component whereas, a large north component is found for this month. At other stations the south component is considerably less pro-

nounced than normal while the resultant velocities in practically all cases exceed their normals.

Pilot balloon observations indicated a well-defined resultant wind which at 1,000 m. was northwesterly over the northern Plains states, westerly over the Great Lakes and New England and southwesterly over the southern Plains states and generally east of the Mississippi River. At 4,000 m. the south component in the monthly resultants is confined to Groesbeck and Key West, the southernmost stations. At San Juan the resultant for the month continues mostly easterly with an appreciable velocity to 4,000 m. From this altitude to 7,000 m. the resultant velocity is too low to be of significance, but above this to 13,000 m. the resultant direction is westerly and the velocity appreciable. This station obtained during the month nine observations exceeding 10,000 m. in altitude.

Free-air observations were secured at Due West on the 10th in the front sector of a pronounced anticyclone. The accompanying changes in temperature, relative humidity and wind direction from the preceding day are shown in the following table, wherein it is evident that the greatest fall in temperature occurred below an altitude of 1,000 m. A strong inversion on the 10th from −3.9° C. at 1,800 m. to 5.3° C. at 2,130 m. clearly marks the upper boundary of this anticyclone at this time. The relative humidity was lower at corresponding altitudes on the 10th than on the 9th, the differences increasing with elevation.

Altitude (m.) m. s. l.	Temperature 9th	Δt./100m. 9th	Temperature 10th	Δt./100m. 10th	Direction 9th	Direction 10th	Relative humidity 9th	Relative humidity 10th
217 (surface)	22.0		9.8		WSW.	NNE.	77	47
500	19.9	0.74	6.3	1.24	W.	N.	80	52
1,000	15.7	0.84	1.5	0.96	W.	N.	88	58
1,500	11.6	0.94	−2.6	0.82	WNW.	NNW.	99	61
2,000	11.0	0.00	1.6	−0.84	WNW.	N.	57	21
2,500	8.3	0.54	4.3	−0.54	WNW.	NNW.	66	9

The kite flight of the 5th at Drexel, made in the rear of a rather weak anticyclone, illustrates the large order of magnitude through which the relative humidity in the free air occasionally changes during a very short time interval. During the ascent of this flight the relative humidity reached a minimum of 29 per cent at 3,648 m. From this altitude it increased to 62 per cent at 4,142 m., the maximum height attained. During the descent, however, the instrument-carrying kite encountered a cloud layer the base of which had lowered since the ascent of the kite flight and consequently a relative humidity of 100 per cent was recorded at the same altitude where an hour previous the low value of 29 per cent obtained. Throughout the descent, i. e., below the cloud base to 2,000 m., the relative humidity was considerably higher than during the ascent, the temperature from 1° C. to 2° C. lower, whereas the wind direction remained WSW. The fall in temperature does not account for the rise in relative humidity, since the vapor pressure increased materially during the descent as compared with corresponding altitudes during the ascent. This saturated condition apparently continued to progressively lower altitudes and showers soon followed with the arrival of a LOW from the west.

In an airplane observation at Washington on the 16th the observer noted both on the ascent and descent a shower of rain falling from a layer of A Cu whose base lay above 3,644 m., the maximum altitude of the flight. The shower extended, however, only about 500 m. below the cloud base, the average relative humidity of the intervening air column being low and the mean lapse rate from the ground to the cloud base only 0.39° C. per 100 m. Due to an approaching LOW from the southwest the surface wind soon shifted to southerly, which resulted in a steeper lapse rate and a rainfall of 0.19 of an inch during the afternoon and evening of the same day.

TABLE 1.—*Free-air temperatures, relative humidities and vapor presures during October, 1925*

TEMPERATURE (° C.)

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters) Mean	Broken Arrow, Okla. (233 meters) Departure from 8-yr. mean	Drexel, Nebr. (306 meters) Mean	Drexel, Nebr. (306 meters) Departure from 10-yr. mean	Due West, S. C. (217 meters) Mean	Due West, S. C. (217 meters) Departure from 5-yr. mean	Ellendale, N. Dak. (444 meters) Mean	Ellendale, N. Dak. (444 meters) Departure from 8-yr. mean	Groesbeck, Tex. (141 meters) Mean	Groesbeck, Tex. (141 meters) Departure from 8-yr. mean	Royal Center, Ind. (225 meters) Mean	Royal Center, Ind. (225 meters) Departure from 8-yr. mean
Surface	11.6	−4.8	3.4	−7.6	16.0	+0.1	0.5	−6.6	16.9	−1.7	6.7	−6.5
250	11.5	−4.8			15.7	+0.1			16.3	−2.1	6.4	−6.6
500	9.9	−5.3	2.8	−7.9	13.6	−0.1	0.3	−6.9	14.8	−2.7	4.3	−7.3
750	9.3	−4.9	1.5	−8.4	12.1	−0.3	−0.3	−7.6	14.0	−2.4	2.6	−7.6
1,000	8.8	−4.3	1.1	−8.1	11.2	−0.2	−1.7	−8.1	14.1	−1.2	1.2	−7.7
1,250	8.4	−3.8	0.7	−7.8	10.1	−0.3	−2.6	−8.2	14.1	−0.3	0.2	−7.5
1,500	8.2	−3.1	0.4	−7.3	8.8	−0.6	−3.6	−8.3	13.7	+0.4	−0.4	−7.0
2,000	7.1	−2.1	−0.7	−6.2	7.2	−0.4	−5.1	−7.7	12.2	+1.0	−2.8	−7.1
2,500	5.4	−1.4	−2.6	−5.5	5.3	−0.7	−6.8	−7.0	9.4	+0.5	−4.7	−6.7
3,000	2.9	−1.2	−5.1	−5.3	3.1	−0.7	−8.9	−6.5	6.6	−0.1	−7.5	−7.1
3,500	0.4	−0.9	−7.4	−5.0	0.4	−0.7	−11.5	−6.3	4.7	+0.2	−9.3	−6.4
4,000	−2.2	−0.7	−10.9	−5.9			−14.0	−6.1	1.4	−0.5		
4,500			−14.2	−6.8			−16.1	−5.4				
5,000							−18.2	−4.9				

RELATIVE HUMIDITY (%)

Surface	74	+7	73	+11	63	+1	75	+7	80	+6	75	+8
250	74	+7			63	+1			80	+8	75	+8
500	74	+10	72	+12	64	+2	74	+8	81	+12	77	+12
750	72	+9	70	+12	65	+3	71	+10	79	+11	80	+16
1,000	67	+6	67	+11	66	+5	71	+12	74	+7	80	+17
1,250	63	+4	65	+11	67	+7	70	+13	67	+2	74	+14
1,500	60	+3	61	+8	66	+8	68	+14	64	+1	65	+9
2,000	55	+4	57	+4	49	−2	60	+10	51	−3	60	+9
2,500	51	+5	58	+6	45	+1	55	+7	55	+2	54	+7
3,000	51	+8	61	+11	42	0	48	+2	51	+5	61	+16
3,500	48	+6	58	+10	41	+1	49	+3	45	+2	55	+12
4,000	53	+14	60	+14			49	+5	54	+12		
4,500			58	+14			40	−3				
5,000							32	−9				

VAPOR PRESSURE (*mb.*)

Surface	11.31	−1.43	5.91	−2.54	13.03	+1.31	4.98	−1.92	17.05	+0.69	7.99	−2.44
250	11.24	−1.41			12.84	+1.28			16.42	+0.69	7.87	−2.44
500	10.18	−1.23	5.59	−2.56	11.68	+1.26	4.86	−1.93	14.96	+0.75	7.02	−2.07
750	9.33	−1.09	4.92	−2.51	10.81	+1.20	4.36	−2.00	13.68	+0.52	6.44	−1.72
1,000	8.57	−0.98	4.52	−2.37	10.22	+1.30	3.99	−1.86	12.61	+0.58	5.86	−1.56
1,250	8.05	−0.65	4.27	−2.05	9.36	+1.29	3.69	−1.62	11.19	+0.35	4.99	−1.60
1,500	7.52	−0.33	3.90	−1.93	8.14	+0.99	3.35	−1.42	10.05	+0.37	4.19	−1.58
2,000	5.97	−0.01	3.51	−1.48	5.00	−0.42	2.68	−1.17	6.94	−0.36	3.47	−0.99
2,500	4.59	+0.04	3.08	−0.99	3.74	−0.36	2.13	−1.01	5.78	+0.03	2.71	−0.80
3,000	3.63	+0.14	2.77	−0.47	2.48	−0.84	1.59	−0.94	4.10	−0.20	2.99	+0.10
3,500	2.59	−0.11	2.43	−0.15	1.56	−1.12	1.43	−0.64	2.66	−0.72	2.84	+0.52
4,000	1.89	−0.15	2.03	−0.07			1.28	−0.34	2.58	−0.22		
4,500			1.89	+0.12			1.08	−0.16				
5,000							0.94	−0.02				

TABLE 2.—*Free-air resultant winds (m. p. s.) during October, 1925*

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		8-year mean		Mean		10-year mean		Mean		5-year mean		Mean		8-year mean		Mean		8-year mean		Mean		8-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	N. 37° E	0.8	S. 2° E	2.1	N. 84° W	1.2	S. 25° W	1.4	N. 46° W	0.7	N. 47° E	2.2	N. 40° W	3.4	N. 09° W	1.7	N. 15° W	0.5	S. 74° E	0.7	S. 71° W	2.8	S. 49° W	2.3
250	N. 38° E	0.8	S. 5° E	2.3					N. 51° W	0.7	N. 47° E	2.3					N 26° W	0.3	S. 51° E	1.1	S. 68° W	3.2	S. 47° W	2.5
500	S. 67° E	0.4	S. 3° W	3.3	S. 85° W	1.8	S. 29° W	2.1	S. 87° W	1.4	N. 52° E	3.1	N. 45° W	3.4	N. 80° W	1.8	S. 48° E	0.3	S. 27° E	2.5	S. 63° W	5.5	S. 53° W	4.7
750	S. 50° W	1.8	S. 12° W	4.1	N. 66° W	3.5	S. 42° W	3.5	S. 73° W	2.8	N. 58° E	2.8	N. 50° W	4.2	N. 88° W	2.7	S. 27° W	1.3	S. 14° E	2.8	S. 63° W	6.5	S. 62° W	5.8
1,000	S. 61° W	2.3	S. 21° W	4.1	N. 55° W	4.4	S. 51° W	3.9	S. 81° W	4.1	N. 54° E	1.9	N. 53° W	5.4	N. 86° W	3.2	S. 33° W	2.1	S. 4° E	2.8	S. 70° W	6.6	S. 68° W	6.3
1,250	S. 65° W	3.1	S. 35° W	4.2	N. 54° W	4.7	S. 61° W	4.5	N. 87° W	6.3	N. 33° E	1.1	N. 43° W	6.0	N. 84° W	3.9	S. 37° W	3.2	S. 5° W	2.9	S. 83° W	9.1	S. 74° W	7.2
1,500	S. 63° W	5.2	S. 42° W	4.5	N. 56° W	5.9	S. 67° W	5.2	N. 87° W	7.6	N. 33° W	0.7	N. 46° W	6.5	N. 85° W	4.6	S. 48° W	4.0	S. 20° W	2.8	S. 85° W	9.5	S. 78° W	8.0
2,000	S. 74° W	6.5	S. 52° W	4.8	N. 68° W	8.6	S. 75° W	7.0	N. 74° W	5.5	N. 59° W	1.2	N. 52° W	7.9	N. 82° W	6.2	S. 51° W	5.5	S. 43° W	2.8	S. 89° W	10.6	S. 81° W	9.1
2,500	N. 82° W	8.0	S. 65° W	5.2	N. 66° W	10.2	S. 80° W	8.2	N. 77° W	11.6	N. 75° W	3.9	N. 47° W	9.8	N. 79° W	7.7	S. 52° W	7.1	S. 63° W	3.2	S. 88° W	12.8	S. 85° W	10.1
3,000	N. 84° W	9.0	S. 70° W	6.4	N. 74° W	13.1	S. 84° W	9.7	N. 86° W	13.3	N. 86° W	5.0	N. 55° W	11.2	N. 81° W	9.0	S. 54° W	9.2	S. 56° W	3.8	N. 84° W	15.2	S. 88° W	11.0
3,500	N. 73° W	11.1	S. 78° W	7.5	N. 79° W	13.9	S. 89° W	10.5	N. 85° W	14.3	N. 83° W	6.8	N. 57° W	13.4	N. 82° W	10.9	S. 65° W	10.1	S. 51° W	4.2	N. 68° W	16.2	S. 85° W	13.0
4,000	N. 78° W	14.0	S. 68° W	8.6	N. 85° W	16.0	S. 86° W	11.6					N. 56° W	14.1	N. 86° W	11.4	S. 43° W	12.3	S. 46° W	4.0				
4,500					N. 45° W	17.0	N. 84° W	12.4					N. 67° W	14.1	S. 82° W	13.2	S. 22° W	9.9	S. 54° W	2.6				

TABLE 3.—*Mean free-air temperatures, relative humidities, vapor pressures, and resultant winds during October, 1925, at Washington, D. C.*

Altitude m. s. l. (meters)	Naval Air Station (7 meters)			Weather Bureau (34 meters)	
				Wind	
	Temperature (° C.)	Relative humidity (per cent)	Vapor pressure (mb)	Direction	Velocity (m. p. s.)
Surface	10.1	77	10.03	N. 65° W.	1.7
150	9.4	72	9.03	N. 41° W.	2.8
100	8.8	68	8.21	N. 70° W.	4.2
250	7.4	68	7.44	N. 87° W.	5.4
5,000	6.0	69	6.91	N. 66° W.	6.4
7,250	4.7	71	6.48		
1,500	3.4	71	5.93	N. 64° W.	8.2
2,000	1.2	75	4.88	N. 83° W.	10.9
2,500	0.5	63	3.69	N. 82° W.	13.5
3,000	−0.8	54	2.78	N. 75° W.	17.5
3,500	−2.8	60	2.82	N. 79° W.	20.5

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

Unlike the preceding month, October had rapid and important pressure variations, and the weather on the whole had a decided winter aspect from the Rocky Mountains eastward, with record-breaking low temperatures over wide areas, frequent rains in the central and eastern districts, some unusually heavy snows for the season, much cloudy weather and a large deficiency in sunshine.

Cyclonic areas during the first half of the month originated mostly in the Southwest, were mainly ill-defined, but frequently were attended by widely distributed precipitation.

During the latter half cyclonic activity shifted to more northern districts and most storms entered the United States from the Canadian Northwest, frequently well east of their usual course and at times followed each other in rapid succession.

No cyclones appear to have entered the United States via the North Pacific States, a condition rarely existing in October.

While precipitation was frequent in most districts from the Rocky Mountains eastward, it was particularly so in the middle Mississippi and Ohio Valley States and thence eastward, where locally the number of days with rain or snow was the greatest ever observed in October. To the north, precipitation was also frequent, but mostly light, while over the cotton-growing States it was both frequent and locally heavy.

Over the Southern States it was usually associated with the general low-pressure conditions existing in that region near the middle of the month and again about the middle of the last decade.

West of the Rocky Mountains cyclonic activity was at a low ebb due to anticyclonic conditions off the Pacific coast, and there was generally little precipitation over the northern districts, but over southern California and near-by portions of Arizona some unusually heavy rains occurred about the 3d to 6th, and important falls were reported from many parts of the plateau and Pacific coast sections from the 9th to 15th.

Anticyclones persisted to a considerable degree over the upper Missouri Valley and northern Rocky Mountain region, and several of unusual intensity for so early in the cool season moved southeastward into the central and eastern districts. The first, bringing important changes in temperature and interruption to the prevalent rainy conditions, was central over the middle Missouri Valley on the morning of the 9th and moved rapidly to the south Atlantic coast by the 11th, attended by decided falls in temperature, the first killing frosts of the season over extensive portions of the interior, and light frosts in in some northern portions of the cotton-growing States.

Another extensive anticyclone entered the upper Missouri Valley on the morning of the 18th and it too moved southeastward, reaching the Gulf coast by the 20th. This likewise was attended by sharp falls in temperature, while frosts occurred somewhat farther south than in the preceding case.

The most important anticyclone, however, entered the northern Rocky Mountain region on the morning of the 27th and gradually overspread the entire country from the Rocky Mountains eastward during the closing days of the month. During its eastward progress the lowest temperatures ever observed in October occurred over large areas from the middle and northern plains eastward to the Ohio Valley and portions of the Northeastern States, and freezing temperatures extended to the middle portions of the Gulf States.

The average pressures were highest over the northern Great Plains and they were generally above normal from the far Northwest eastward to the upper Lakes and generally over the middle and southern plains. Over most districts from the Great Lakes, Ohio and lower Mississippi Valleys eastward the average pressures were mainly below normal, the deficiencies increasing toward the Canadian Maritime Provinces. Over the greater part of the plateau and Pacific Coast States the average pressures were below normal.

Compared with September the average pressures were far higher over the central valleys and Northwest, but considerably lower over eastern Canada and the Northeastern States.

High winds over extensive areas were confined mainly to the Great Lakes region and North Atlantic coast, though local storms of some severity were reported from limited areas in many districts from the Rocky Mountains eastward. The greatest number was reported on the 24th and 25th when considerable damage occurred over southern and eastern districts, a severe tornado occurring in the early morning of the 25th in southeastern Alabama, causing the loss of 18 lives and heavy damage to property; also, in the vicinity of Woburn, Mass., on the same date, beside one fatality, six persons were injured and many buildings wrecked. The details concerning these and other storms of the month appear at the end of this section.

The distribution of the average atmospheric pressure favored northerly winds over the central valleys and most southern districts from Texas eastward. Over the Great Lakes and Ohio Valley the winds were mainly from the west or southwest. Elsewhere they were chiefly variable.

TEMPERATURE

Probably the most pronounced change from normal conditions, in a month of many abnormalities, was the widespread deficiency in temperature, embracing nearly the entire country and continuous to an unusual extent throughout the month. No previous October in the past 50 years or more has had temperatures so low on the whole over nearly all central and northern districts from the Rocky Mountains eastward, and the minimum readings for the month, mostly near the end, were likewise the lowest ever observed over much of the same area. In some cases, notably in South Dakota and adjacent areas, the lowest temperatures were from 5° to 15° lower than ever before observed in October. Chart III shows the area and amount of the deficiency in temperature as compared with normal October values. The only previous October in the past 50 years having similar temperature conditions was in 1917, which was slightly cooler than the present October in a few southern localities, though the area of large negative departure was not so extensive as in the present month. Over the Florida peninsula and small areas of the East Gulf and South Atlantic States the month was slightly warmer than normal, and similar conditions prevailed along the Pacific coast from central California to northern Washington.

The first week was mostly warmer than normal over the Southern States, a continuation of the condition existing during September, but elsewhere, particularly over the northern Great Plains and in the Northeast, this week was distinctly cold. For the 7-day period ending October 13 temperatures continued low over all northern districts and the cold advanced southward into the region where high temperatures had persisted during the previous week, so that only small areas of the Gulf and South Atlantic States had average temperatures appreciably above the normal. A narrow area along the North Pacific coast also had averages slightly above normal, but elsewhere the week was nearly continuously cold.

The third week was on the whole again colder than normal over all parts of the country, save from the Gulf coast northeastward to the Middle Atlantic States. Over the central valley, Great Plains, and Rocky Mountain sections the weekly averages ranged from 6° to 12° below normal.

The final decade experienced rapid weather changes east of the Rocky Mountains and toward the end the severest and most widespread cold wave ever known in October overspread the northern and central portions of this area.

The highest temperatures occurred usually during the first decade, the 7th and 8th being particularly warm in the Gulf States where locally the readings were the highest ever observed in October. Over the Atlantic coast States, however, the warmest days were the 16th and 17th, when locally in North Carolina and Virginia temperatures were the highest ever experienced so late in the month.

From the Rocky Mountains eastward the lowest temperatures were observed almost universally during the severe cold wave of the 28th–31st. Elsewhere they occurred mainly on the 14th–15th and 24th–25th.

The lowest temperature observed was −28° at a point in Montana, and readings of −15° to −20° were reported from Iowa, Nebraska, and the Dakotas, and of zero or lower as far south as Missouri. Temperatures below freezing were reported from some point in all the States except Florida, where the lowest observed was 37°.

The protection afforded the Northern States west of the Rocky Mountains from the cold waves to the eastward, was well illustrated during the month. Immediately west of the mountains in Idaho 8° was the lowest. Similarly in eastern Wyoming −20° occurred, while west of the divide in Utah and Idaho it was nearly 30° warmer.

PRECIPITATION

Precipitation also showed abnormal variations; most important being the early occurrence of phenomenally heavy snowfall for October in many parts of the eastern two-thirds of the country, and the total number of days with rain or snow over the same area, which in many instances broke October records.

The total precipitation was in a few instances in excess of any previously reported for October, notably in portions of West Virginia and southern California. On the other hand, in the far Northwest and over central and northern California the month was notably dry, a few localities in the former region having as little precipitation as in any previous October of record. There was a slight deficiency from the middle plains northeastward to the upper Lakes and over Florida and along the South Atlantic coast.

The plentiful precipitation over most districts was in sharp contrast to that of many of the months preceding and very generally relieved the severe drought in the southeast, except in a few localities of the southern Appalachians, where precipitation was barely sufficient to keep stream flow at the level existing at the beginning of the month.

Precipitation was far in excess of the normal over the lower Mississippi Valley and middle Gulf States, from Iowa and Missouri eastward to the Atlantic coast and over New England, and there was a marked excess in southern California, with moderate excesses over much of the western mountain regions. The precipitation was well distributed through all parts of the month except in the far West where it was limited to a few dates only, and, while far in excess of present requirements in many localities, and interfering greatly with outdoor occupations, still it was needed to replenish the water supplies which had become greatly depleted during the long drought.

SNOWFALL

Over most of the northern and central districts from the Rocky Mountains eastward snow was observed earlier than ever before known and the depths were the greatest of record for October.

Monthly amounts ranging up to 2 feet or more were reported from the eastern slopes and foothills of the Rocky Mountains from Colorado to Montana, and from 5 to 10 inches or more in portions of the Great Lakes, New York and New England. Farther south amounts were usually less, but in practically all cases the depths were far greater than ever before measured in October, and in many instances it was the first occurrence of record in that month.

In the vicinity of Washington, D. C., it is recorded that snow fell on October 24, 1853, to varying depths, Winchester, Va., reporting a "remarkable snowstorm, 10 to 12 inches," and "deep snow" was reported from other points near-by.

West of the Rocky Mountains snowfall occurred only at the higher elevations and the depths were not unusual for October.

RELATIVE HUMIDITY

Over a narrow area along the entire Atlantic coast and including the Florida peninsula the average relative humidity was slightly less than normal, and similar conditions existed along the Pacific coast from central California to Washington. Otherwise the relative humidity was above normal in all parts of the country, the excesses being conspicuously large in the regions with a corresponding deficiency in temperature.

SUNSHINE AND CLOUDINESS

October is usually a month of abundant sunshine, often attended by a hazy or slightly smoky condition of the atmosphere and generally associated with moderate warmth, frequently constituting a near return to summer. No such conditions were experienced during this month. The amount of sunshine in many sections was only a small fraction of the possible, and cloudy weather predominated to an unusual degree over the eastern two-thirds of the country. Over the districts to westward of the Rocky Mountains, however, conditions were largely reversed and locally the amounts of sunshine were far in excess of those usually received.

SEVERE LOCAL HAIL AND WIND STORMS

The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path [1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Detroit, Mich.	2					Thunderstorm and downpour.	Several districts flooded; telephone and electric power service interrupted; traffic delayed; some damage by lightning.	Free Press (Detroit, Mich.)
Keokuk, Iowa	2-3					Thunderstorm and hail.	600 panes of glass broken in greenhouse; other minor damage.	Official, U. S. Weather Bureau.
Gevin (near), Iowa	3	2 a. m.	880		$3,000	Small tornado	Outbuildings, orchards, and timber damaged; much corn blown down. Path 1½ miles long.	Do.
Greenfield, Ill.	3					Electrical	36 hogs killed by lightning; no other loss reported.	Do.
Atlanta, Mo.	4	1 p. m.	1,760-2,200		5,000	Thundersquall and hail.	Buildings unroofed, chimneys blown down; crops damaged to the amount of $1,500 by hail. Path 20 miles long.	Do.
Memphis, Tenn.	4				1,500	Thunderstorm	Houses, electric light and power lines damaged.	Do.
Fresno (near), Calif.	5	4-5 p. m.	3,520		50,000	Heavy hail and rain.	Aside from hail damage, there was considerable rain damage to grapes on vines, also to basement stocks of merchandise by flooding. Path 20 miles long.	Do.
West Chesapeake Bay section, Md.	10					Wind	Corn in shocks damaged, trees uprooted and some fruit blown off; communication interrupted locally.	Do.
New Jersey (northern half of)	10			1		Severe wind	Insecure structures wrecked; plate glass windows broken; branches torn from trees and shrubbery. Live wire caused 1 death at Orange.	Official, U. S. Weather Bureau.
New York, N. Y., and vicinity.	10			5		Wind	Many small boats and several barges wrecked on the Hudson; wire service impaired; 18 boats valued at $500,000 swept on rocks off Kingsland Point.	Boston Transcript (Mass.).
New England	10-11			1		Wind, rain, snow, and electrical.	Heavy property damage; apple crop suffered severely; much wire damage; along coast ships held up and small craft in trouble. Many serious accidents occurred.	Boston Transcript (Mass.). Hartford Courant (Conn.);
Comite (near), La.	14	8:37 a. m.		5	1,200	Small tornado	Small home destroyed; other houses moved from foundations; trees damaged; storm covered about an acre.	Official, U. S. Weather Bureau.
Southern Oklahoma	14	3:30-7:30 p. m.	2-12 mi.		1,262,000	Severe wind and hail.	One person injured at Pittsburg where storm was most severe; extensive property and crop (principally cotton) damage; damage by hail estimated at $1,035,000.	Do.
Fisher, Hall, Jones, and Childress Counties, Tex.	14					Hail and wind	Many acres of cotton and feed crops ruined; loss in Hall County alone estimated at $1,000,000.	Dallas Morning News (Tex.)
Clarksville, Tenn.	16					High winds	Slight damage reported.	Official, U. S. Weather Bureau.
Alloway, Perry Co., Ky.	16			1	5,000	Small tornado	Nine persons injured in mining camp.	Do.
Warren County, northeast, into Estill County, Ky.	16		150-440	1	250,000	Tornado	Heaviest damage in Warren, Hart and Marion Counties; 11 persons seriously and 33 slightly injured.	Do.
Northern Michigan	18-19					High wind, and snow.	Many lake wharves damaged; elevator tower demolished; navigation completely halted; much damage to overhead wires; traffic impeded.	Official U. S. Weather Bureau; Ludington Daily News. (Mich.)
Buffalo, N. Y. and vicinity.	19					High wind	Trees, wires, and signs blown down; maximum wind velocity 74 miles.	Official U. S. Weather Bureau.
Calhoun, Ga.	19					Moderately high winds.	Dwellings and barns damaged.	Do.
Vermilion Parish, La.	24	11:30 p. m.				Wind squall	Houses moved from foundations; trees injured.	Do.
Calhoun County, Ala. (north part of).	24	P. m.				Thunderstorm	Hotel at Piedmont Springs damaged, trees and several houses blown down; communication hampered. Five persons injured near Maxwellborn.	Anniston Star (Ala.)
Allentown, Pa.	24-25					High winds and rain.	Orchards considerably injured; telephone and telegraph communication interrupted; lighting system temporarily out of use.	Official, U. S. Weather Bureau.
Berks County, Pa.	24-25					High winds and rain.	Much minor damage reported.	Do.

[1] Yards when not otherwise specified; "mi" signifies miles.

Severe local hail and wind storms—Continued

Place	Date	Time	Width of path	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Philadelphia, Pa.	24-25					Wind and rain	Trees uprooted, obstructing traffic; other minor damage.	Official, U. S. Weather Bureau.
Port Arthur, Tex.	24					Thunderstorm	Electric lines affected	Do.
Crenshaw, Pike, southern Bullock and northern Barbour Counties, Ala.	25	2-4 a. m.	400	18	$250,000	Tornado	Very heavy property damage; many persons injured. Path, 75 miles long.	Do.
Abbeville, Anderson, Greenville, Laurens and Spartanburg Counties, S. C.	25	5:40-7 a. m.	300-8,800		100,300	Thunderstorm, hail, and destructive winds.	Extensive property damage over path 50 miles long; 5 persons injured.	Do.
Woburn, Mass., and vicinity	25	3:13 p. m.		1		Tornado	75 buildings wrecked; 6 persons injured while many narrowly escaped death.	Boston Post (Mass.); Boston Daily Globe (Mass.).
Atlanta, Ga.	25					Wind	Large church tent blown down	Official, U. S. Weather Bureau.
Baltimore, Md.	25	P. m.		1		Wind	17 Navy seaplanes torn from anchorage off Dundalk; all damaged, 2 wrecked beyond repair; minor damage in city; several persons injured.	Do.
Maryland	25				8,300	Wind	Property and crop damage at Belair, Delmar, Keymar, Millsboro, Maryland Line, Massey and Saint Inigoes; also in parts of Washington, Frederick and Carroll Counties.	Do.
New Jersey (southern half and coast section).	25			1		Severe wind	Some buildings damaged, others wrecked; farm buildings, shore cottages, and wires hard hit.	Do.
New York, N. Y., and vicinity.	25					Strong winds	Considerable damage to buildings and shipping in city; minor damage in other parts of State.	Do.
Piedmont, Wyo.	29			1		Thunderstorm	No property damage reported	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

October, 1925, was a stormy month, and warnings were required for the Atlantic coast north of Cape Hatteras in connection with seven storms. Ordinarily, October is a rather quiet month in the Washington forecast district, with few disturbances of consequence crossing the country and with many pleasant days and few rainy. Quite different conditions prevailed during the month just ended. At Washington, D. C., there were 14 days with precipitation of 0.01 inch or more, as compared with a normal of 9 days, and only 4 clear days, as compared with a normal of 14. Moreover, the temperature was above normal on only 6 days, while it was 12 or more degrees below normal on 7 days. In spite of the unseasonably low temperatures, killing frost did not occur at Washington until the 28th, the average date of the first killing frost in autumn being October 20.

The first storm of consequence developed over the middle Atlantic States during the 9th and moved rapidly northeastward. Storm warnings were ordered displayed at 9.30 p. m. from Jacksonville, Fla., to Eastport, Me. The highest recorded wind velocities were: Sixty miles from the northwest at Cape Henry, Va., 80 miles from the northwest at New York City, and 52 miles from the east at Eastport, Me.

The least important of the seven storms referred to was that of the 14th–15th, for which storm warnings were issued from Delaware Breakwater to Eastport. The only verifying velocity reported was 48 miles from the southeast at Atlantic City, N. J.

During the remainder of the month storms followed in rapid succession, and warnings were issued as follows: 16th, 10 p. m., Delaware Breakwater to Eastport, Me.; 17th, 10 a. m., south of Delaware Breakwater to Cape Hatteras; 19th, 10.30 a. m., Cape Hatteras to Boston, Mass.; 24th, 4 p. m., Delaware Breakwater to Eastport, Me., and 25th, 10 a. m., south of Delaware Breakwater to Wilmington, N. C.; 28th, 4 p. m., Cape Hatteras to Block Island, R. I.; 30th, 4 p. m., Jacksonville, Fla., to Boston, Mass. These warnings were all well verified. The most severe storm was that of the 24th–25th. A disturbance that developed over Oklahoma and northern Texas during the 22d–23d had advanced to extreme southern Illinois by the morning of the 24th and to Ohio by the night of the same date. Up to this time it was only of moderate intensity, but there were indications of increased development, so, southeast storm warnings were ordered displayed at 4 p. m. from Delaware Breakwater northward. During the night of the 24th the disturbance increased greatly in intensity and on the morning of the 25th, it was centered over western New York as a severe storm with strong indications that a secondary disturbance was developing over the middle Atlantic States. This secondary quickly formed and at noon was centered near New York City with a barometer reading of 29.10 inches. The secondary, as was expected, soon became the principal storm, and moved very rapidly northeastward, the center being near Eastport at 8 p. m. with a barometer reading of 28.80 inches. During the ensuing 24 hours this severe storm moved rapidly northeastward over the Canadian Maritime Provinces. The following high wind velocities were reported; 88 miles from the northwest at New York City, 64 miles from the southwest at Sandy Hook, Block Island, and Atlantic City, and 60 miles from the southwest at Cape Henry.

Small-craft warnings were issued as follows: 16th and 30th, Pensacola, Fla., and Mobile, Ala., sections; 25th, Charleston, S. C., Savannah, Ga., and Jacksonville, Fla., sections.

Frost warnings were issued for some part of the Washington district on 14 dates during the month, the most important being those issued on the 9th, 10th, 19th, 20th, and 28th. Frost had occurred by the end of the month as far south as the central portions of Mississippi, Alabama, and Georgia.

Cold-wave warnings were issued for western Pennsylvania, southern Ohio, eastern and central Kentucky, and northwestern West Virginia on the 28th, and for southern Alabama, extreme northwestern Florida, and the Mississippi coast on the 30th. These warnings were only partially verified.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

Rarely in the past has October in the Chicago forecast district been so cold and inclement in general as was the month under discussion. As a matter of fact, this was the coldest October in more than half a century over virtually the entire district. Moreover, there was a marked excess of cloudy, wet weather, and over large areas the snowfall was the heaviest ever recorded for October. So-called "Indian summer" weather was almost totally lacking, a feature that was the subject of widespread comment and discussion, both on the part of the public and press.

Storm warnings.—Two or three storms of considerable intensity affected the Great Lakes during the month, and in addition there were several disturbances of less importance that called for storm warnings of more or less general scope. Thus, either storm or small-craft warnings were issued on a total of 14 days.

On the 6th rather general warnings were disseminated in connection with a disturbance that had formed two days previously over the northern Rocky Mountain region and moved eastward with increasing force. Winds of from strong to gale force occurred over most of Lakes Superior, Erie, and Ontario in this connection.

The next warning was issued on the 9th for a disturbance that developed over the Middle Atlantic States and in conjunction with a large high pressure area over the northern Great Plains caused winds of from strong to gale force over the Lower Lakes, as well as southern Lake Huron. The warning in question was intended for small craft, whereas a storm warning would have been justified. The wind continued strong over most of the Lower Lakes on the 10th.

On the 14th northwest storm warnings were issued for eastern Lake Superior and northern Lake Huron, and small-craft warnings advised for the Lower Lakes and southern Lake Huron for a disturbance that moved from the far Northwest and reached Lake Superior with increased energy. For the most part the warnings were justified. A second disturbance quickly followed on the 15th, for which small-craft warnings were advised for Lake Superior.

The next storm to call for warnings was present on the afternoon of the 16th over the Arkansas Valley, moving northeastward, and apparently about to increase in force. Accordingly, northeast warnings were issued for southern Lake Michigan, but were recalled when the evening reports indicated that the disturbance had not developed to any extent. However, a sudden and marked increase in intensity took place that night, and the center of the storm had moved to eastern New York by the morning of the 17th. As a result, small-craft warnings were advised for the Lower Lakes from Cleveland, Ohio, east.

One of the most important storms developed over the Upper Lakes on the 18th. On the morning of that date small-craft warnings were advised for Lake Superior and northern Lake Michigan, and at night storm warnings were issued for most of the Upper Lakes section. On the following morning these were extended over southern Lake Huron and the Lower Lakes. This storm was of considerable severity along the eastern shore of Lake Michigan, where at Grand Haven, Mich, a maximum velocity of 53 miles an hour was reached.

A disturbance that developed over the southern Great Plains and moved northeastward across the Ohio Valley called for southeast storm warnings on the morning of the 24th over most of the Lower Lakes section, and small-craft warnings for southern Lake Huron and extreme western Lake Erie. However, the warnings were recalled 12 hours later when it appeared that the sidturbance was losing force. But, as in the storm of the 16th-17th, a marked increase in intensity occurred over night, so that storm warnings had to be issued on the 25th for Lakes Huron and Ontario, as well as Lake Erie from Cleveland, Ohio, east; and small-craft warnings were advised for western Lake Erie.

On the morning of the 26th northwest storm warnings were issued for Lakes Michigan and Huron and southwest warnings for Lake Erie for a disturbance then over the middle Mississippi Valley. In the afternoon the warnings were extended over Lakes Superior and Ontario. The disturbance lost force, with the result that no high winds of consequence occurred. However, in connection with a marked area of high pressure over the northern Rocky Mountain Region and a depression of increasing depth over Lake Superior, northwest warnings were continued on Lake Superior on the 27th, as well as issued for Lake Michigan and northern Lake Huron. On the next day the warnings were extended over the remainder of the Lakes. Although verifying wind velocities did not occur at all stations, there is no question that the warnings were justified. On portions of Lake Superior this storm was rather severe.

Frost warnings.—At the beginning of October the growing season, already over in most of the extreme northern portion of the district, was terminated over the remainder except in the extreme south, by the general cool wave at the close of the first decade. After the 10th a few frost warnings were issued until the final warning of the 24th for southeastern Kansas. The frost warnings of this month were not of great economic importance, inasmuch as virtually all staple products had matured before frost occurred.

Cold-wave warnings.—These were issued on the 25th for a limited portion of the northwestern Great Plains area and on the 27th for most of the extreme southern part of the district. The cold period that occurred at this time was among the most notable in the history of the Weather Bureau for so early in the season, and record low temperatures prevailed over wide areas from the 28th to the 30th. At Rapid City, S. Dak., the phenomenally low minimum of −13° occurred. This is 15° lower than any previous reading at that station for October.

Livestock warnings.—Forecasts for the benefit of stock interests were issued on the 5th, 25th, and 27th. That of the 25th proved to be most timely.

Special forecasts.—A special forecast for the benefit of the contestants in the first annual Detroit News ballooning trophy race was made on the 3d. Although the forecast was for distinctly unfavorable conditions, nevertheless the flight was held, with the result that most of the balloonists had a most perilous trip.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

High pressure over the northern portion of the country, with relatively low pressure over the Southwestern States, prevailed during much of the month. attended by comparatively wet, cold weather in this forecast district. Nevertheless, the first week was unseasonably warm because the hot weather of September continued into October, there being no invasion of colder air from the north until the closing days of the first decade. The mean temperature for the month was the lowest of record in Oklahoma and the north portion of west Texas.

The p. m. map of the 24th showed a moderate disturbance over south Texas, with a strong gradient thence northward to Oklahoma. Northwest storm warnings were ordered for the Texas coast from Port Arthur to Freeport and northwest gales of brief duration occurred within the ensuing six hours. The gradient had greatly diminished by the next morning and the warnings were lowered.

Northwest storm warnings were issued for the Texas coast on the 27th at 8:30 p. m., because of a well-developed area of high pressure which was moving rapidly southeastward from the northern Rocky Mountain

States. The pressure gradient diminished as the HIGH advanced to the coast and winds did not reach verifying velocity.

Small-craft warnings were displayed on the Texas coast on the 9th, 19th, 26th, and 30th, and the afternoon of the 23d; and on the Louisiana coast on the 28th and 30th; also by the official in charge at Corpus Christi, Tex., on the afternoon of the 24th. These warnings were justified.

A cold wave of unusual severity for so early in the season overspread the northern portion of the district on the 28th–29th, for which cold-wave warnings had been issued on the a. m. map of the 27th for Oklahoma and the north portion of west Texas, extended on 2 p. m. special observations for Arkansas and north and central Texas, and further extended at night and the following morning for the remainder of the district. A marked change to unseasonably cold weather extended to the coast; but on account of the rapid eastward movement of the area of high pressure the isobars assumed an east-west trend, and cloudy weather, with rain, occurred in the more southern sections of the district, preventing the low temperature required for a cold wave. On the 30th, with low pressure moving eastward over the Gulf of Mexico while low temperatures continued, freezing weather threatened in the interior sections of the southern portion of the district; but the weather remained cloudy, preventing frost and freezing temperature that were forecast for the morning of the 31st.

Besides the warnings issued during the last few days of the month, frost or freezing temperature was forecast for northern sections of the district on the 9th, 10th, 17th, 18th, and 24th, and for most northern and central sections on the 19th, 20th, and 26th; and conditions occurred mostly as forecast.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

October weather was unusual in several respects. Temperatures averaged below normal generally, especially in eastern Colorado and southwestern Arizona. The mean temperature at Denver was the lowest of record for October. A great deal of cloudiness prevailed; the percentage of possible sunshine was less than half the normal at Denver, while at Phoenix and Yuma, Ariz., the percentages were the lowest of record. A new record for the number of days with precipitation in October was established at Denver, there being 15 days with 0.1 inch or more, the previous record being 12 days. Precipitation was above normal except in northwestern Utah, southeastern Colorado, and southeastern New Mexico. The amounts received at the various stations varied from about double the normal to several times normal. At Yuma, Ariz., there has been only one other October in 56 years having as much rain as this one.

These unusual conditions resulted mainly from almost continuously high barometric pressure to the north and rast of the district. Some of the HIGHS that crossed this eegion were of unusual intensity for so early in the season.

The one that appeared over Alberta on the morning of the 25th was drawn southward into Montana by the movement of a disturbance from the northeastern Rocky Mountain slope to Texas; it remained over the northern States, with varying intensity, until the morning of the 27th, by which time a rather energetic disturbance had developed in eastern Colorado. As it was evident that the displacement of this LOW would result in a cold wave, warning of a moderate cold wave was issued to eastern Colorado, including advices to livestock interests in southeastern Colorado. This warning was verified. Cold waves in any part of the Denver district in October are of rare occurrence.

Warnings of frost and freezing temperature, nearly all of which were justified, were issued to various parts of the district almost daily from the 1st to the 26th, by which time killing frosts had occurred everywhere except in the extreme southern portion of the district.—*E. B. Gittings, jr.*

SAN FRANCISCO FORECAST DISTRICT

The weather during October, 1925, was remarkable for the small amount of precipitation recorded, except in southern California and the Plateau region. A small depression developed over the lower Colorado River Valley during the first week and gave heavy rain in southern California, especially in the extreme south and Mojave desert and more than normal amounts in Nevada and southern Idaho. In the North Pacific States very little rain fell, and was mostly confined to western Washington during the last decade.

To understand the unusual condition which prevailed, it is necessary to study the distribution of barometric pressure over Bering Sea, Alaska, and the north Pacific Ocean. The pressure was low over Bering Sea and Alaska until the 21st, when an area of high pressure appeared over the Pribilof Islands and moved rapidly eastward over northern Alaska and disappeared to the east on the 25th. The area of high pressure was closely followed by another large storm which continued over the north Pacific and Alaska until the end of the month. A ridge of high pressure continued off the coast during the entire month. This distribution of pressure caused all storms from the ocean to pass inland north of Queen Charlotte Island.

Southwest storm warnings were ordered on the Washington coast on the 24th, but no verifying velocities occurred. Advisory warnings of storm conditions along the Great Circle route to the Orient were sent several times to North Pacific stations for the benefit of shipping bound for the Orient and Alaska. Warnings of expected high seas along the coast were sent frequently to the United States engineers building the jetty at the mouth of Humboldt Bay.

Special forecasts for fruit driers in the valleys of northern California were broadcast daily and were appreciated, as shown by the following extracts from letters received: From horticultural commissioner, Sutter County: "We have appreciated the service you have given us this season and hope to be able to take advantage of it another year." From county agent, Sonoma County: "I wish to express for the growers their appreciation of the service this year, and especially for the 12:30 p. m. radio reports."—*G. H. Willson.*

RIVERS AND FLOODS

By R. E. SPENCER

The only important flood of the month occurred following the 17th in the White River of Arkansas and its tributaries. The river, still high as a result of precipitation on the 7th and 8th, rose rapidly following rather heavy rains on the 16th, passing flood stage at several stations (see table). Warnings, which were issued well in advance of the flood, resulted in a saving of $88,000 in that portion of the inundated area from which reports could be obtained, while unavoidable losses, principally in cotton and corn crops, were estimated as follows:

Crops	$170,000
Livestock	2,000
Suspension of business	8,000
Total	180,000

Owing to a levee break in the lower St. Francis River of Missouri, a considerable area of farm land in Dunklin County was overflowed on the 24th. No definite reports of damage have been received except that a newspaper estimate places crop losses at something less than $100,000.

Rises in the San Antonio and Dallas districts were well forecast and were attended by only slight losses and a considerable saving in livestock.

Heavy local rain in western Colorado on the 5th resulted in losses in highways and bridges and railroad property estimated (by newspaper) as at least $100,000.

River	Station	Flood stage	Above flood stages—dates		Crest	
			From—	To—	Stage	Date
Mississippi drainage:		Feet			Feet	
Grand	Gallatin, Mo.	20	4	5	25.0	5
	Chillicothe, Mo.	18	4	7	20.8	6
Canadian	Logan, N. Mex.	4	2	2	5.6	2
Petit Jean	Danville, Ark.	20	16	20	23.4	18
White	Batesville, Ark.	23	17	18	25.5	17
	Newport, Ark.	26	19	20	26.1	19
	Georgetown, Ark.	22	18	29	23.3	23–24
Black	Black Rock, Ark.	14	16	30	20.7	18
Cache	Patterson, Ark.	9	15	(1)	10.5	22
West Gulf drainage:						
Trinity	Dallas, Tex.	25	18	18	25.8	18
Little	Little River, Tex.	30	17	17	34.6	17
Colorado	Columbus, Tex.	28	14	15	33.0	15
Guadalupe	Victoria, Tex.	16	14	14	16.2	14
			17	20	21.5	19
Rio Grande	Rio Grande City, Tex.	15	1	2	19.0	1
	San Benito, Tex.	21	(2)	6	24.3	3 and 4

[1] Continued at end of month.
[2] Continued from last month. River above flood stage following Sept. 26, 1925.

MEAN LAKE LEVELS DURING OCTOBER, 1925

By UNITED STATES LAKE SURVEY

[Detroit, Mich., Nov. 5, 1925]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes[1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during October, 1925:	Feet.	Feet	Feet	Feet
Above mean sea level at New York	601.38	577.89	570.53	244.32
Above or below—				
Mean stage of September, 1925	−0.02	−0.33	−0.37	−0.24
Mean stage of October, 1924	−0.46	−1.31	−1.17	−1.13
Average stage for October last 10 years	−1.14	−2.36	−1.48	−1.32
Highest recorded October stage	−2.26	−5.15	−3.17	−3.49
Lowest recorded October stage	−0.20	−1.31	−0.27	+0.65
Average departure (since 1860) of October level from September level	−0.06	−0.23	−0.32	−0.35

[1] Lake St. Clair's level: In October, 1925, 573.20 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, OCTOBER, 1925

By J. B. KINCER

General summary.—The persistence of cloudy and rainy weather from the middle and upper Mississippi Valley eastward made conditions decidedly unfavorable for farm work, with a consequent delay in the usual fall operations. It was especially unfavorable for drying corn and for seeding fall grains. Rainfall relieved the severe drought in the Southeast, however, which made much more favorable conditions in that area, and the soil at the close of the month was in generally good shape, though more rain was needed locally in Florida. The rains in the South revived pastures and improved late truck and other minor crops, but there was some delay to field work in central and west Gulf sections.

The first general frost of the season over the interior of the country occurred from the 8th to the 12th, but no widespread or material harm resulted because of the advanced condition of crops. The freezing temperatures near the close of the month, however, caused damage to undug potatoes, and in some sections to unpicked apples, over a wide area from the northern Plains eastward. West of the Rocky Mountains the weather conditions were generally favorable, though the soil continued too dry in parts of the Pacific Northwest.

Small grains.—Wet weather from the central Mississippi Valley eastward was unfavorable for seeding winter wheat during most of the month, and this work was much delayed. The early-seeded grain germinated satisfactorily, however, and was generally in good condition at the close of the month. Over the Great Plains area and in the Southwest rainfall was lighter and seeding made good progress, while the breaking of the drought in the Southeast facilitated the seeding of fall grains in that area. In the Northeast buckwheat was unfavorably affected by wet weather, particularly in New York.

Corn.—In the central and eastern portions of the Corn Belt it continued generally too cloudy and wet for drying out corn, and husking was delayed. There was some damage by molding in shock in the Ohio Valley States, and to both shocked and outstanding corn in the upper Mississippi Valley, particularly in Iowa. In the Great Plains States conditions were more favorable, and mostly good progress was made in gathering the crop, though the grain dried slowly in parts of this area and there was considerable complaint of high moisture content of grain. In the Southeast there was some interruption by the heavy rainfall to harvesting the latter part of the month

Cotton.—The weather was decidedly unfavorable for outstanding cotton over the central-northern and northwestern portions of the belt, although the latter part of October was much more favorable by reason of less rainfall and more sunshine. In the sections where rain was frequent much damage was done to open cotton by lowering of grade, and picking was practically at a standstill during part of the month. Near the close, freezing temperatures overspread the northwestern cotton districts, which stopped further growth and damaged immature bolls. In the eastern portions of the belt conditions were more favorable, though there was some interruption by rain to picking in the northeast during the latter part of the month.

Miscellaneous crops.—In the Southeastern States fall truck and miscellaneous crops were materially improved by generous rains, while conditions were mostly favorable in central and west Gulf sections. There was considerable complaint of potatoes rotting in New York because of wet soil, and widespread harm was done to undug potatoes in many Northern States by freezing weather near the close of the month. There was considerable delay to sugar-beet harvest by frequent rains, though this work was facilitated in the western Plateau districts by increased soil moisture. Pastures improved generally in the Southeast, and conditions were mostly favorable for grazing interests in the West. In the central and eastern portions of the country pastures were in good condition for the season.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number stations.

Condensed climatological summary of temperature and precipitation by sections, October, 1925

Section	Temperature							Precipitation					
			Monthly extremes							Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	65.3	+0.3	Evergreen	98	7	Saint Bernard	26	29	5.77	+2.99	Bridgeport	11.47	Marion	2.50
Alaska (*September*)	48.4	+2.6	5 stations	73	[2] 5	Wonder Lake	15	[2] 24	5.10	−0.79	Speel River	10.35	Salt Chuck	1.81
Arizona	61.2	−1.2	2 stations	105	[2] 1	Bright Angel Ranger Station.	10	14	1.90	+0.93	Yeager Canyon	4.65	Cove Ranch	0.29
Arkansas	58.7	−3.6	2 stations	98	[2] 1	Dutton	13	31	7.75	+4.75	Clinton	13.89	Prescott	3.57
California	59.2	−1.3	Greenland Ranch	102	2	Helm Creek	7	14	1.20	−0.02	Amago	6.32	11 stations	0.00
Colorado	43.3	−3.0	Lamar	99	3	Crested Butte	−7	[2] 25	2.00	+0.76	Palisade Lake	5.73	Blanca	0.08
Florida	75.3	+2.3	Blountstown	99	8	3 stations	37	[2] 21	3.37	−1.00	Saint Andrews	7.92	Homestead	0.43
Georgia	66.0	+1.2	4 stations	98	[2] 7	Clayton	25	[2] 11	4.48	+1.66	Resaca	7.75	Brooklet	1.66
Hawaii	74.6	+0.7	Mahukona	93	13	Waimea	50	8	4.31	−1.39	Intake, Wainiha Power Canal.	18.60	Kaanapali	0.10
Idaho	45.1	−1.7	3 stations	80	[2] 1	2 stations	8	[2] 9	1.21	−0.20	Pete King	4.16	Rupert	0.20
Illinois	46.3	−8.9	Harrisburg	90	1	La Harpe	1	30	4.04	+1.46	Cairo	10.53	Casey	1.72
Indiana	47.0	−7.6	Mount Vernon	86	1	Marengo	9	29	3.80	+1.10	Rome	7.29	Royal Center	1.63
Iowa	40.3	−11.8	Stockport	78	2	Inwood	−15	29	2.91	+0.49	Burlington	5.68	Alton	0.97
Kansas	47.9	−9.2	Medicine Lodge	97	3	Ulysses	3	30	1.54	−0.36	McFarland	5.15	Kismet (near)	0.15
Kentucky	52.9	−5.2	Dix Dam	88	4	Farmers	13	29	7.09	+4.49	Paducah (near)	11.50	Grant	3.87
Louisiana	69.0	+1.1	Plain Dealing	90	7	2 stations	31	[2] 20	8.90	+5.71	Lake Charles	16.17	Minden	3.18
Maryland-Delaware	51.2	−5.2	Millsboro, Del	87	17	2 stations	16	[2] 29	5.38	+2.50	Oakland, Md	9.48	Solomons, Md	3.28
Michigan	40.8	−8.3	Sodus	83	[2] 1	Ironwood	2	30	3.14	+0.35	Munising	5.33	Escanaba	1.08
Minnesota	35.3	−10.9	2 stations	71	[2] 1	Grand Meadow	−5	30	0.95	−0.93	Gonvick	2.92	Artichoke Lake	0.19
Mississippi	65.2	+0.1	Shubuta	100	7	3 stations	25	29	7.71	+5.22	Woodville	13.29	Collins	3.73
Missouri	48.6	−8.8	Caruthersville	92	1	2 stations	−3	30	4.85	+2.10	Dexter	11.44	Bolivar	1.56
Montana	35.3	−8.0	Harlowton	77	1	Biddle	−28	28	1.46	+0.42	Adel	7.19	Mildred	0.17
Nebraska	40.8	−10.1	Culbertson	89	1	Hay Springs	−15	28	1.74	+0.18	Ainsworth	3.50	Haigler	0.45
Nevada	50.2	−1.2	Las Vegas	98	3	2 stations	14	[2] 3	1.03	+0.45	Lovelock	2.37	North Fork	0.25
New England	42.7	−6.1	Boston, Mass	79	17	Van Buren, Me	1	31	4.74	+1.13	Woodland, Me	9.08	Bennington, Vt	2.81
New Jersey	49.1	−5.9	Tuckerton	84	17	Layton	12	31	4.59	+0.90	South Orange	5.78	Northfield	3.38
New Mexico	52.9	−0.6	Carlsbad	98	[2] 2	Elizabethtown	6	15	1.43	+0.11	Bateman Ranch	4.05	Levy	0.20
New York	42.9	−7.0	Port Jervis	79	16	Indian Lake	2	31	4.10	+0.74	High Market	8.05	Lauterbrunnen	1.77
North Carolina	58.4	−1.6	Goldsboro	95	17	Mount Mitchell	10	20	3.50	+0.32	Highlands	8.47	Willard	1.65
North Dakota	33.3	−10.5	Hettinger	66	10	Carson	−16	29	0.78	−0.22	Howard	2.46	2 stations	0.05
Ohio	46.3	−7.7	3 stations	83	[2] 1	Bellefontaine	11	29	4.37	+1.71	Wilmington	9.62	Van Wert	1.69
Oklahoma	55.4	−6.4	Mangum	97	2	3 stations	13	30	2.81	−0.36	Watts	8.72	Goodwell	0.45
Oregon	50.1	−0.2	Marshfield	91	20	Blitzen	10	24	0.55	−1.58	Classic Lake	2.66	6 stations	0.00
Pennsylvania	46.1	−6.5	2 stations	83	[2] 1	Bradys Bend	9	29	4.83	+1.50	Elk Lick	8.90	Sharon	2.02
Porto Rico	78.1	−0.1	Arecibo	97	26	Jayuya	54	20	7.04	−1.27	Maricao	23.95	Mona Island	0.64
South Carolina	63.9	+0.4	Georgetown	98	5	Caesar's Head	26	[2] 29	2.93	−0.06	Caesar's Head	6.35	Wedgefield	0.70
South Dakota	37.0	−11.5	Academy	81	5	3 stations	−18	28	0.82	−0.52	Oelrichs	3.20	Onida	T.
Tennessee	57.1	−2.8	McMinnville	93	1	2 stations	20	29	8.10	+5.18	Covington	13.05	Greeneville (near)	4.22
Texas	64.8	−2.7	2 stations	101	[2] 3	Dalhart	13	28	4.75	+2.16	Galveston	17.34	Riogrande	0.35
Utah	47.7	−0.7	Saint George	95	3	2 stations	11	[2] 24	1.48	+0.16	New Harmony	4.03	Wendover	0.21
Virginia	53.7	−4.0	Runnymede	91	17	Burkes Garden	15	29	4.33	+1.10	Dante	7.46	Langley Field	2.12
Washington	49.0	−1.1	4 stations	81	[2] 4	Bumping Lake	17	31	1.28	−1.39	Snoqualmie Pass	7.80	Tieton Canyon	0.00
West Virginia	49.3	−6.0	2 stations	86	[2] 1	Smithfield	11	29	7.30	+4.44	Bruceton Mills	13.08	Upper Tract	2.19
Wisconsin	38.2	−9.8	Manitowoc	74	1	Long Lake	−7	30	2.04	−0.58	Racine	4.44	Danbury	0.64
Wyoming	36.1	−6.7	Fort Laramie	85	1	Rockypoint	−20	28	1.97	+0.86	Dome Lake	5.38	Eden	0.35

[1] For description of tables and charts, see REVIEW, January, 1925, page 42.
[2] Other dates also.

TABLE I.—*Climatological data for Weather Bureau stations, October, 1925*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0–10	In.	In.
New England							45.3	−5.7										73	4.39	+0.8										6.1		
Eastport	76	67	85	29.76	29.84	−.16	42.4	−5.1	61	16	49	24	31	36	23	39	36	78	5.84	+2.0	14	8,343	w.	60	e.	10	5	10	16	6.7	0.6	0.0
Greenville, Me	1,070	6		28.69	29.87		36.4		61	2	44	18	31	29	33				6.02		16	6,165	nw.	78		10	9	11	11	5.4	T.	0.0
Portland, Me	103	82	117	29.80	29.93	−.11	44.5	−5.4	67	16	52	25	31	38	26	39	34	73	4.75	+1.1	14	7,057	w.	46	nw.	10	8	11	12	6.1	1.3	0.0
Concord	288	70	79	29.60	29.92	−.13	42.2	−7.5	68	16	51	18	31	33	37				4.25	+1.0	14	4,445	nw.	34	nw.	10	8	11	12	6.1	1.3	0.0
Burlington	404	11	48	29.48	29.93	−.11	40.5	−8.7	64	16	47	17	31	34	29				3.99	+0.8	17	7,984	nw.	44	nw.	26	3	9	19	7.4	5.1	0.0
Northfield	876	12	60	28.98	29.94	−.10	37.6	−7.9	64	17	47	9	31	28	39	35	32	82	4.17	+1.7	22	5,029	s.	34	s.	28	3	9	19	7.6	9.9	T.
Boston	125	115	188	29.80	29.93	−.12	49.3	−4.3	79	17	57	30	31	42	28	43	37	69	4.03	+0.2	11	7,535	w.	43	w.	10	6	14	11	6.3	T.	0.0
Nantucket	12	14	90	29.91	29.92	−.13	49.9	−4.3	69	17	56	32	30	44	19	45	41	74	4.60	+1.2	15	11,875	w.	63	sw.	25	7	9	15	6.8	0.2	0.0
Block Island	26	11	46	29.91	29.94	−.11	50.0	−4.9	69	17	55	31	30	45	18	45	40	72	4.51	+0.4	13	14,950	w.	72	nw.	10	6	10	15	6.6	0.3	0.0
Providence	160	215	251	29.77	29.95	−.10	47.4	−4.8	78	17	56	29	31	39	31	41	35	66	3.53	−0.3	11	10,254	nw.	72	w.	25	11	9	11	5.1	T.	0.0
Hartford	159	122	140	29.79	29.96	−.10	46.7	−4.5	76	17	55	25	31	38	30				3.92	+0.1	12		sw.				13	7	11	5.1	0.1	0.0
New Haven	106	74	153	29.85	29.97	−.09	48.2	−5.6	77	17	56	26	31	40	29	43	37	69	4.68	+0.8	12	6,758	nw.	40	sw.	25	16	5	10	4.5	1.3	0.0
Middle Atlantic States							50.9	−5.5										73	3.86	+0.6										6.9		
Albany	97	102	115	29.85	29.96	−.10	45.3	−6.8	75	17	53	22	31	38	32	41	37	77	2.75	−0.2	16	5,147	nw.	35	s.	14	8	10	13	6.2	0.9	T.
Binghamton	871	10	84	29.02	29.97	−.09	43.4	−6.6	71	17	51	20	31	36	31				2.62	−0.5	17	4,727	nw.	33	nw.	10	2	5	24	8.3	3.0	0.5
New York	314	414	454	29.64	29.98	−.08	49.9	−6.4	76	17	56	31	29	44	27	44	38	69	4.13	+0.4	13	14,367	nw.	84	nw.	10	5	13	13	7.0	0.4	T.
Harrisburg	374	94	104	29.62	30.02	−.06	48.3	−6.5	71	17	54	27	31	42	24	43	39	72	6.03	+3.1	13	5,044	nw.	36	w.	25	6	9	16	6.8	2.1	T.
Philadelphia	114	123	190	29.88	30.00	−.07	52.2	−5.6	77	17	59	29	31	45	23	46	40	66	4.14	+1.0	12	6,606	nw.	48	s.	25	4	13	14	6.6	1.1	T.
Reading	325	81	98	29.65	30.01		48.6		73	17	56	25	31	42	26	44	41	77	4.58	+1.3	12	5,109	nw.	44	w.	25	6	9	16	7.1	1.1	T.
Scranton	805	111	119	29.12	30.00	−.07	45.5	−6.4	71	17	52	22	31	35	26	43	41	90	2.93	0.0	16	5,159	n.	32	nw.	10	3	5	23	8.1	2.7	1.5
Atlantic City	52	37	172	29.93	29.99	−.08	52.6	−4.3	82	17	60	31	29	46	28	48	42	70	3.65	+0.4	13	13,064	w.	68	s.	25	8	8	15	6.1	0.0	0.0
Cape May	17	13	49	30.02	30.04	−.03	53.8	−5.8	78	17	61	32	31	46	26	49	44	74	3.41	+0.1	15	6,485	nw.	34	nw.	25	6	5	20	7.3	T.	0.0
Sandy Hook	22	10	55	29.95	29.97		51.0		75	17	57	31	31	45	23	45	40	69	4.06		13	12,978	nw.	68	nw.	10	4	12	15	6.5	T.	0.0
Trenton	190	159	183	29.78	29.99		49.7		77	17	57	26	31	42	27	44	38	67	3.97	+0.6	13	8,254	nw.	56	nw.	10	6	7	18	7.1	1.0	T.
Baltimore	123	100	113	29.87	30.00	−.08	52.7	−5.5	76	17	59	30	31	46	22	47	42	71	5.43	+2.4	13	4,317	sw.	33	w.	25	6	11	14	6.5	2.5	0.0
Washington	112	62	85	29.89	30.01	−.07	52.0	−5.4	78	17	59	30	31	45	27	47	42	74	4.86	+1.8	14	4,730	nw.	40	nw.	10	4	9	18	7.1	2.2	T.
Cape Henry	18	8	54	29.98	29.99		59.5		90	17	66	40	20	54	25	54	50	73	2.35	−1.5	10	11,858	nw.	60	nw.	10	6	9	16	6.6	0.0	0.0
Lynchburg	681	153	188	29.28	30.03	−.06	52.8	−5.7	80	3	61	29	28	44	25	47	43	75	4.08	+0.7	14	5,096	w.	41	nw.	25	6	12	13	6.4	2.9	0.0
Norfolk	91	170	205	29.92	30.02	−.05	58.7	−3.8	87	17	66	35	29	52	25	52	48	72	2.22	−1.7	10	10,054	n.	59	nw.	25	6	9	16	6.6	0.0	0.0
Richmond	144	11	52	29.87	30.03	−.05	55.1	−4.5	86	17	64	30	29	46	27	49	45	74	4.67	+1.4	12	5,814	ne.	46	sw.	25	8	9	14	6.4	T.	0.0
Wytheville	2,304	49	55	27.63	30.02	−.07	49.8	−3.8	75	3	58	22	20	42	29	46	42	79	3.73	+0.6	16	4,503	w.	27	nw.	22	5	9	17	6.9	2.4	T.
South Atlantic States							63.9	−0.4										75	2.95	−0.7										5.3		
Asheville	2,255	70	84	27.68	30.04	−.05	53.6	−1.7	78	4	62	26	29	45	38	48	44	77	2.74	+0.3	11	6,444	se.	30	nw.	28	7	11	13	6.1	T.	0.0
Charlotte	779	55	62	29.19	30.03	−.05	59.4	−2.3	87	16	69	31	29	50	30	52	47	71	2.98	−0.2	13	3,558	ne.	24	sw.	25	11	6	14	5.7	0.0	0.0
Hatteras	11	11	50	29.98	29.99	−.07	64.6	−1.3	82	5	71	44	20	59	20	59	56	78	4.07	−1.9	10	11,893	n.	53	nw.	10	9	9	13	5.7	0.0	0.0
Raleigh	376	103	110	29.62	30.03	−.04	58.8	−3.2	88	17	67	32	29	50	27	52	48	74	2.16	−1.3	13	5,890	sw.	38	sw.	25	10	8	13	6.0	0.0	0.0
Wilmington	78	81	91	29.94	30.03	−.03	64.5	−0.8	88	5	73	38	11	56	27	58	54	77	3.61	−0.1	12	5,368	n.	30	w.	22	11	8	12	5.4	0.0	0.0
Charleston	48	11	92	29.97	30.02	−.04	68.8	+1.0	92	5	76	46	29	62	24	62	59	77	3.08	−0.8	10	8,249	sw.	32	s.	18	12	11	8	5.1	0.0	0.0
Columbia, S. C	351	41	57	29.65	30.03	−.04	65.0	+0.7	92	7	74	39	29	56	29	57	52	73	1.14	−1.7	8	5,110	ne.	30	sw.	17	13	8	10	4.8	0.0	0.0
Due West	711	10	55	29.28	30.06		61.0		89	7	70	35	11	52	33				3.51		9	6,590	sw.	48	w.	25	13	6	12	5.1	0.0	0.0
Greenville, S. C	1,039	139	146	28.92	30.02		59.8	−0.4	88	7	68	34	29	51	26	53	48	72	4.71		13	6,904	ne.	44	w.	25	14	6	11	5.0	0.0	0.0
Augusta	182	62	77	29.82	30.02	−.05	65.8	+0.5	93	7	75	41	11	56	33	59	55	75	3.27	+0.9	9	4,248	nw.	46	w.	25	14	6	11	4.8	0.0	0.0
Savannah	65	150	194	29.95	30.02	−.03	69.7	+1.8	94	8	78	45	21	61	27	62	58	76	3.32	−0.2	6	8,086	ne.	40	nw.	10	13	11	7	4.6	0.0	0.0
Jacksonville	43	200	245	29.97	30.02	.00	72.6	+1.5	93	8	81	48	22	65	28	64	61	76	3.13	−1.9	7	8,471	sw.	33	sw.	25	12	7	12	5.4	0.0	0.0
Florida Peninsula							79.4	+2.3										77	2.35	−3.4										3.9		
Key West	22	10	64	29.96	29.98	+.04	81.5	+2.4	90	20	86	67	23	76	16	75	73	77	3.14	−2.2	8	6,495	se.	25	e.	10	19	8	4	3.3	0.0	0.0
Miami	25	71	79	29.98	30.01		80.0	+2.2	90	5	85	58	22	75	19	74	71	77	1.12	−7.8	9	4,534	se.	19	e.	17	17	10	4	4.0	0.0	0.0
Tampa	35	79	87	29.96	30.00	+.02	76.7	+2.4	92	8	85	54	22	68	25	69	67	76	2.78	−0.2	7	4,185	ne.	19	sw.	28	12	14	5	4.5	0.0	0.0
Titusville	44	5					77.0		96	15	87	46	22	67	32				3.81		9		sw.				14	8	9		0.0	0.0
East Gulf States							66.5	+0.1										78	5.79	+3.0										5.8		
Atlanta	1,174	190	216	28.81	30.04	−.03	61.2	−1.8	88	7	70	30	29	53	26	55	51	73	4.55	+2.2	13	8,116	nw.	46	w.	25	12	5	14	5.6	0.0	0.0
Macon	370	78	87	29.63	30.03	−.03	65.0	+0.5	94	7	75	37	29	55	33	58	54	75	4.53	+2.4	12	4,629	nw.	30	w.	25	14	5	12	5.0	0.0	0.0
Thomasville	273	49	58	29.73	30.02	−.02	70.4	+2.2	93	8	80	43	21	61	33	62	59	77	5.36	+1.9	9	3,570	ne.	20	sw.	25	7	11	13	6.4	0.0	0.0
Apalachicola	36	42	49	29.97	30.01		73.0		91	9	80	47	21	66	22	67	65	81	3.81		11	6,674	n.	34	ne.	10	15	9	7	4.5	0.0	0.0
Pensacola	56	149	185	29.95	30.01	−.02	70.6	+0.7	90	5	77	45	29	64	26	65	63	80	3.37	−0.7	13	10,201	n.	44	s.	14	13	6	12	5.4	0.0	0.0
Anniston	741	9	57	29.26	30.06	−.01	62.0	−0.4	92	4	73	29	29	51	36				7.42	+5.1	14	3,775	nw.	25	nw.	9	14	7	10	4.6	0.0	0.0
Birmingham	700	11	48	29.29	30.05	−.02	63.6	−1.2	95	7	74	29	29	54	34	56	52	76	6.19	+3.8	13	5,008	n.	25	s.	16	11	6	14	5.6	0.0	0.0
Mobile	57	125	161	29.95	30.01	−.03	70.4	+1.1	94	4	78	42	29	63	28	64	61	81	5.35	+2.2	14	7,645	n.	40	n.	10	8	13	10	5.9	0.0	0.0
Montgomery	223	100	112	29.79	30.04	−.02	66.6	0.0	92	7	76	36	29	58	31	60	55	73	3.60	+1.2	12	4,994	n.	30	w.	25	12	6	13	5.5	0.0	0.0
Corinth	469	6					60.6		91	4	70	27	29	51	25				7.86		14		se.				3	20	8		0.0	0.0
Meridian	375	85	93	29.64	30.03	−.03	65.0	+0.7	92	7	74	32	29	56	36	58	56	81	5.99	+3.3	12	4,063	n.	32	w.	25	11	5	15	5.7	0.0	0.0
Vicksburg	247	65	73	29.76	30.04	−.02	64.9	−1.8	91	4	72	36	30	57	29	59	56	81	9.42	+6.6	14	4,637	ne.	27	w.	24	8	8	15	6.4	0.0	0.0
New Orleans	53	76	84	29.96	30.01	−.02	72.2	+1.2	92	7	79	46	29	65	23	66	63	80	7.96	+5.0	13	4,871	ne.	28	nw.	30	10	11	10	5.4	0.0	0.0
West Gulf States							68.3	−2.6										79	6.56	+3.8										6.3		
Shreveport	249	77	93	29.75	30.02	−.03	64.2	−2.4	94	3	72	33	30	56	30	59	56	78	5.80	+2.6	9	4,698	ne.	34	sw.	16	12	5	14	5.7	0.0	0.0
Bentonville	1,303	11	44				52.5	−5.5	86	3	62	21	31	43	37				5.85		10	3,585	ne.	16	s.	27	11	4	16		0.3	0.0
Fort Smith	457	79	94	29.54	30.03	−.02	57.8	−5.0	91	3	66	27	31	49	31	52	48	77	5.42	+2.6	9	5,555	e.	42	nw.	14	11	5	15	5.8	T.	0.0
Little Rock	357	136	144	29.66	30.03	−.03	59.3	−4.3	91	4	67	29	31	51	31	54	50	77	5.73	+3.2	14	5,688	n.	34	s.	16	10	6	15	5.8	T.	0.0
Brownsville	57	53	61	29.88	29.94		74.5	−0.4	91	2	81	42	30	68	29	70	68	87	3.99		13	6,320	s.	25	s.	25	8	11	12	6.1	0.0	0.0
Corpus Christi	20	11	73	29.96	29.98	−.02	72.5	−0.7	93	14	79	41	30	66	25	68	66	84	3.12	+1.1	10	9,665	s.	43	n.	25	8	11	12	6.0	0.0	0.0
Dallas	512	109	117	29.47	30.02		63.6		94	4	72	33	30	55	28				4.47		9	5,047	s.	24	ne.	26	9	11	11	5.8	0.0	0.0
Fort Worth	670	106	114	29.29	30.00	−.03	63.6	−3.1	96	4	72	30	28	55	31	56	51	69	3.77	+1.1	7	6,271	n.	46	nw.	24	10	11	10	5.8	0.0	0.0
Galveston	54	106	114	29.95	30.01	−.02	71.0	−1.7	87	5	76	41	31	66	23	67	65	83	17.34	+13.2	14	7,588	s.	37	nw.	16	7	9	15	6.7	0.0	0.0
Groesbeck	461	11	55	29.52	30.00		64.0		92	6	72	33	29	56	27				6.89		11	7,193	n.	37	nw.	16	7	11	13	6.4	0.0	0.0
Houston	138	111	121	29.85	30.00		66.6	−0.7	93	5	78	39	31	62	30				5.99		13	4,948	n.	29	n.	24	7	11	13	6.4	0.0	0.0
Palestine	510	64	72	29.49	30.02	−.01	64.4	−2.8	93	6	72	33	28	56	26	59	55	80	6.73	+3.1	13	5,120	sw.	24	s.	16	3	13	15	6.3	0.0	0.0
Fort Arthur	34	58	66	29.96	30.00		69.6		91	5	76	40	31	63	27	64	62	84	10.13		13	6,537	s.	36	nw.	24	9	6	16	6.7	0.0	0.0
San Antonio	693	119	132	29.27	29.99	−.02	68.6	−1.9	92	8	77	36	29	60	26	61	58	73	2.23	+0.7	8	5,590	s.	30	n.	24	2	13	16	7.1	0.0	0.0
Taylor	583	55	63	29.42	30.04	+.02	66.1	−2.2	93	7	74	34	29	58	27				8.94	+6.4	10	6,354	n.	29	nw.	24	3	13	15	7.1	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau stations, October, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In	In.	In.	°F.	°F.	F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0–10	In.	In.
							51.4	−6.3										76	6.32	+1.8										7.6		
Ohio Valley and Tennessee																																
Chattanooga	762	180	213	29.22	30.03	−.06	59.6	−2.3	87	4	69	28	29	50	32	53	48	72	11.91	+9.1	15	5,787	nw.	36	nw.	9	9	9	13	5.8	0.0	0.0
Knoxville	996	102	111	28.97	30.03	−.06	57.0	−2.9	81	4	65	29	29	51	32	53	50	79	8.72	+6.0	13	4,841	sw.	34	sw.	17	7	9	15	6.4	0.0	0.0
Memphis	399	76	97	29.61	30.04	−.03	58.9	−4.4	89	4	66	29	30	51	25	53	50	78	9.51	+6.9	14	4,841	sw.	43	sw.	16	12	6	13	5.7	0.0	0.0
Nashville	546	168	191	29.47	30.06	−.02	57.0	−4.0	87	4	65	26	29	49	29	51	47	76	8.72	+6.0	13	5,515	n.	36	nw.	9	7	8	16	6.5	1.0	T.
Lexington	989	193	230	28.97	30.04	−.04	50.2	−7.2	75	4	57	21	29	43	22				6.99	+3.5	16	6,551	nw.	38	w.	26	3	4	24	8.2	2.8	0.0
Louisville	525	188	234	29.47	30.06	−.02	51.4	−7.9	78	4	58	23	29	45	20	46	42	76	5.83	+3.6	19	8,479	sw.	37	nw.	19	3	5	23	8.1	3.5	0.0
Evansville	431	139	175	29.59	30.06	−.02	51.2	−8.2	79	4	58	23	29	45	23	47	44	79	6.43	+3.8	15	7,169	n.	37	nw.	26	3	13	15	7.3	5.0	T.
Indianapolis	822	194	230	29.15	30.03	−.02	46.6	−9.1	77	1	53	22	28	40	21	42	39	80	6.25	+3.2	15	6,951	ne.	37	nw.	26	2	6	22	7.7	1.4	0.0
Royal Center	736	11	55	29.22	30.04	------	43.4	------	79	1	51	16	30	36	25				4.16	+1.4	20	7,304	nw.	42	w.	26	2	6	23	7.8	1.3	0.0
Terre Haute	575	96	129	29.42	30.05	------	47.6	------	78	2	54	20	29	41	23	43	40	79	6.25	------	18	6,125	w.	36	w.	26	2	7	22	7.8	0.1	0.0
Cincinnati	627	11	51	29.36	30.05	−.03	48.4	−7.3	75	2	55	20	29	42	23				1.83	------	13	6,066	nw.	34	nw.	26	2	7	22	8.2	4.7	T.
Columbus	822	179	222	29.15	30.04	−.04	47.0	−8.2	77	1	54	21	29	40	20	43	39	79	4.24	+1.9	17	4,556	sw.	31	nw.	25	0	8	23	8.7	3.0	0.0
Dayton	899	137	173	29.06	30.03	------	47.0	−8.0	77	1	54	21	29	40	20	42	40	81	3.71	+1.4	15	6,128	w.	46	w.	26	2	7	22	8.1	2.8	T.
Elkins	1,947	59	67	27.96	30.04	−.06	47.6	−4.7	74	17	56	21	31	40	32	42	40	84	3.93	+1.5	15	5,945	w.	37	w.	26	1	9	21	8.0	5.5	1.4
Parkersburg	637	77	82	29.39	30.05	−.03	50.9	−5.2	80	1	58	24	29	44	23	45	42	78	6.85	+4.4	19	4,265	w.	36	w.	25	1	7	23	8.5	3.7	0.0
Pittsburgh	842	353	410	29.11	30.02	−.06	47.2	−8.5	72	1	54	23	29	41	30	43	40	79	5.87	+3.4	17	3,926	sw.	32	nw.	26	3	5	23	8.4	4.9	0.5
																			4.09	+1.7	17	7,840	w.	54	w.	25	1	7	23	8.4		
																		78												7.6		
							43.8	−8.3											3.68	+0.7												
Lower Lake Region																																
Buffalo	767	247	280	29.14	29.98	−.07	43.0	−8.9	66	2	49	24	29	37	22	40	38	83	2.77	−0.8	17	12,581	w.	74	w.	19	3	8	20	7.6	2.7	0.0
Canton	448	10	61	29.43	29.92	------	39.8	−7.4	64	2	48	15	30	32	30				3.73	+0.4	19	6,640	w.	44	sw	25	9	5	17	6.8	6.3	0.1
Oswego	335	76	91	29.59	29.94	−.11	43.0	−8.2	61	1	49	23	31	37	24	40	36	78	4.52	+1.2	23	8,377	nw.	44	w	25	4	7	20	7.5	7.8	0.5
Rochester	523	86	102	29.40	29.99	−.06	43.8	−7.7	66	2	50	23	31	37	25	39	36	77	3.40	+0.5	40	8,286	sw.	40	sw.	25	4	7	20	7.5	0.8	0.0
Syracuse	507	97	113	29.31	29.97	−.09	42.6	−8.4	62	1	49	20	31	37	25				3.72	+0.5	16	6,027	sw.	49	nw	25	4	6	21	7.6	4.4	T.
Erie	714	130	166	29.21	29.99	−.06	44.8	−8.6	69	2	50	27	31	39	20	41	38	80	5.40	+1.6	21	8,286	w.	48	nw	25	2	6	23	8.2	14.7	T.
Cleveland	762	190	201	29.18	30.01	−.05	45.2	−8.4	69	2	50	26	29	40	17	41	37	76	3.38	+0.6	21	10,232	s.	48	n.	9	1	5	25	8.4	1.8	T.
Sandusky	629	62	70	29.33	30.02	−.04	45.5	−8.8	71	2	51	23	29	39	19	41	37	79	2.43	0.0	18	9,162	sw.	48	n.	9	2	6	23	8.1	1.2	0.0
Toledo	628	208	243	29.34	30.03	−.02	44.8	−8.6	71	2	51	22	29	40	19	41	38	80	3.09	+0.8	14	6,186	sw.	34	n.	19	5	8	18	7.2	1.2	0.0
Fort Wayne	856	113	124	29.09	30.03	------	45.2	−8.5	78	1	52	20	29	39	23	41	38	74	2.55	------	15	8,761	sw.	44	w.	18	3	9	19	7.4	1.4	T.
Detroit	730	218	258	29.22	30.02	−.03	44.4	−8.1	66	1	50	24	29	39	18	39	35	74	4.35	+2.0	17	5,798	w.	30	w.	19	3	10	18	7.5	2.0	T.
																					17	7,022	w.	38	w.							
							40.0	−8.7										80	2.70	−0.1										7.7		
Upper Lake Region																																
Alpena	609	13	92	29.31	29.98	−.05	39.2	−7.9	58	2	45	16	30	33	27	36	33	80	1.44	−2.0	19	7,645	nw.	46	w.	19	2	10	19	7.5	4.0	0.0
Escanaba	612	54	60	29.33	30.01	.00	38.0	−8.0	59	1	45	10	30	31	23	34	31	78	1.08	−2.0	13	7,368	nw.	33	nw.	19	6	10	15	6.5	0.9	0.0
Grand Haven	632	54	89	29.31	30.01	−.02	42.5	−8.2	69	3	48	22	30	36	20	39	36	80	3.11	+0.6	17	7,912	w.	53	w.	19	1	10	20	8.2	4.6	T.
Grand Rapids	707	70	87	29.24	29.99	−.01	42.9	−8.3	70	1	49	24	28	37	23	39	36	79	3.52	+1.0	18	3,766	nw.	30	nw.	19	1	4	26	9.0	7.5	T.
Houghton	668	62	99	29.24	30.02	−.02	37.2	−8.5	56	2	42	12	30	32	20				2.92	−0.3	18	6,539	w.	35	w.	19	1	4	26	8.7	16.9	5.0
Lansing	878	11	62	29.06	30.02	------	41.4	−8.9	72	1	49	25	29	37	18	38	35	78	4.25	+2.0	18	3,402	w.	21	nw.	19	3	9	19	7.3	2.7	0.0
Ludington	637	60	66	29.30	30.01	------	41.6	------	63	3	46	25	29	37	21	34	30	79	2.88	------	18	7,942	w.	49	nw.	19	4	10	17	7.5	3.5	0.0
Marquette	734	77	111	29.18	29.99	−.02	38.0	−8.7	57	13	43	14	30	32	21	39	36	81	2.44	−0.8	18	8,151	w.	39	s.	31	5	3	23	7.8	5.3	0.8
Port Huron	638	70	120	29.29	30.00	−.04	42.1	−8.4	67	1	48	19	29	36	21	39	36	81	3.08	+0.4	17	7,615	nw.	46	w.	19	2	13	16	7.0	2.0	0.0
Saginaw	641	------	------	29.30	30.00	------	40.6	−9.7	65	3	48	19	30	32	23	34	31	80	2.47	------	19	------	------	------	------	------	------	------	------	------	0.4	T.
Sault Sainte Marie	614	11	52	29.27	29.98	−.03	37.4	−7.2	54	3	42	15	30	32	23	41	36	71	3.72	+1.2	19	5,709	nw.	38	nw.	6	0	9	22	8.5	5.6	0.1
Chicago	823	140	310	29.14	30.04	.00	45.0	−10.1	70	1	51	19	28	40	18	41	36	80	2.26	−1.0	16	7,105	nw.	35	nw.	26	4	6	21	7.5	1.2	0.0
Green Bay	617	109	141	29.33	30.00	−.02	39.0	−9.5	65	1	46	12	30	32	21	36	32	77	2.05	−0.3	12	8,115	w.	35	w.	18	2	12	17	7.4	1.4	0.0
Milwaukee	681	125	139	29.28	30.02	−.01	42.1	−9.0	69	1	48	18	30	36	19	38	35	77	3.69	+1.3	14	6,609	w.	28	se.	26	5	7	19	7.2	2.0	0.1
Duluth	1,133	5	47	28.78	30.03	+.03	34.2	−9.9	60	2	41	8	30	28	25	31	29	86	1.59	−1.2	15	9,038	w.	50	nw.	28	5	7	19	7.5	11.5	0.0
																		79												6.5		
							33.7	−9.6											0.85	−0.4												
North Dakota																																
Moorehead	940	50	58	29.02	30.06	+.06	34.6	−9.9	60	5	42	4	29	27	31	31	27	78	0.63	−1.4	8	5,989	nw.	26	n.	5	3	13	15	7.6	2.8	0.0
Bismarck	1,674	8	57	28.31	30.14	+.15	34.4	−10.5	62	10	43	−3	29	26	42	30	26	77	0.55	−0.5	8	6,514	nw.	38	nw.	22	11	7	13	5.5	2.8	0.0
Devils Lake	1,478	11	44	28.44	30.06	+.07	32.4	−8.1	53	12	40	3	29	25	27	28	25	81	1.27	0.0	13	6,995	nw.	27	nw.	5	8	9	14	6.3	10.2	0.0
Ellendale	1,457	10	56	28.48	30.06	------	34.4	------	64	5	43	3	29	26	36	------	------	------	0.48	------	13	9,199	nw.	48	nw.	5	6	6	19	6.9	2.3	0.0
Grand Forks	835	12	89	------	------	------	34.0	------	57	12	41	5	29	27	31	------	------	------	0.89	------	9	------	nw.	48	s.	30	7	5	19	------	5.4	0.0
Ellendale	1,457	10	56	28.48	30.06	------	34.0	------	57	12	41	5	29	27	31	------	------	------	1.05	+0.3	8	6,066	w.	34	nw.	13	9	9	13	6.2	6.1	0.0
Grand Forks	835	12	89	------	------	------	33.4	−10.0	57	4	42	0	29	25	34	29	26	79	------	------	------	------	------	------	------	------	------	------	------	7.3		
Williston	1,878	41	48	28.07	30.11	+.13	33.4	−10.0	57	4	42	0	29	25	34	29	26	79	1.05	+0.3	8	6,066	w.	34	nw.	13	9	9	13	6.2		
																		80	2.99	+0.6												
							42.9	−10.2																								
Upper Mississippi Valley																																
Minneapolis	918	102	208	29.03	30.04	------	38.2	−10.7	60	11	44	10	30	32	20	------	------	------	0.58	−2.0	9	8,042	n.	34	n.	5	4	7	20	7.7	3.3	0.0
St. Paul	837	236	261	29.11	30.04	+.03	37.7	−10.9	63	2	44	8	30	31	21	------	------	------	0.83	−1.5	8	8,465	nw.	35	nw.	19	2	12	17	7.3	6.7	0.0
La Crosse	714	11	48	29.25	30.03	+.01	39.8	−10.5	64	2	47	7	30	33	25	------	------	------	1.73	−0.7	15	3,338	w.	16	s.	31	4	7	20	7.8	1.6	T.
Madison	974	70	78	28.98	30.05	+.02	39.9	−10.4	64	2	46	13	29	34	22	36	33	79	1.92	−0.5	13	5,623	nw.	25	ne.	26	4	9	19	7.8	2.7	T.
Wausau	1,247	4	------	28.66	30.02	------	37.0	------	62	3	43	8	30	31	22	------	------	------	1.27	------	13	------	------	------	------	------	2	8	20	8.2	6.4	T.
Charles City	1,015	10	49	28.97	30.07	+.05	37.8	−10.8	63	15	45	1	30	30	28	34	32	82	1.98	0.0	16	4,695	nw.	24	nw.	19	2	9	19	7.2	4.2	0.5
Davenport	606	71	79	29.39	30.06	+.02	42.6	−11.1	72	2	50	11	28	36	28	39	36	80	3.01	+0.6	15	4,564	nw.	24	nw.	19	1	5	25	7.9	4.8	2.5
Des Moines	861	84	97	29.15	30.07	+.04	41.6	−11.8	71	3	50	7	28	34	28	38	33	78	3.22	+0.5	12	5,066	n.	22	sw.	10	5	7	19	7.5	7.9	T.
Dubuque	700	81	96	29.28	30.04	.00	40.9	−11.0	67	2	47	10	30	36	21	37	33	78	2.67	0.0	13	4,284	nw.	21	nw.	26	3	4	24	8.1	3.9	T.
Keokuk	614	64	78	29.39	30.08	+.03	44.2	−11.2	75	2	52	13	30	36	27	40	37	78	2.56	+0.1	13	4,744	nw.	29	nw.	26	6	7	18	6.6	0.1	
Cairo	358	87	93	29.66	30.05	−.02	53.6	−6.8	84	4	61	26	29	47	23	49	46	81	10.53	+7.9	13	6,022	n.	31	n.	26	6	7	18	7.0	2.0	0.0
Peoria	609	11	45	29.40	30.07	+.02	43.4	−8.6	76	1	53	13	30	39	23	42	39	82	2.23	−0.4	16	3,795	nw.	23	nw.	26	2	6	23	7.8	2.9	1.1
Springfield, Ill	636	10	91	29.36	30.04	−.01	46.0	−9.8	77	2	54	13	30	38	27	------	------	------	2.49	−0.1	16	5,110	n.	30	w.	26	4	8	18	7.8	2.8	T
Hannibal	534	74	109	29.49	30.07	+.02	46.0	−10.0	77	2	54	13	30	38	27	------	------	------	2.23	−0.4	14	5,372	nw.	28	nw.	26	4	10	17	7.2	3.6	T
St. Louis	568	265	303	29.45	30.06	.00	49.5	−8.8	80	2	56	21	30	43	21	45	41	75	3.73	+2.1	14	5,372	nw.	28	nw.	26	4	9	18	7.3	0.1	0.0
																			4.32	+1.9	10	8,101	s.	44	nw.							
																		74												6.4		
							43.2	−10.4											2.03	+0.2												
Missouri Valley																																
Columbia, Mo	784	11	84	29.22	30.07	+.02	47.2	−9.4	79	2	55	20	28	39	32	------	------	------	4.63	+2.2	10	5,174	n.	30	nw.	21	3	13	15	7.3	0.8	0.0
Kansas City	963	161	181	29.03	30.08	+.04	47.6	−10.1	88	3	55	17	30	40	29	43	38	75	3.89	+1.7	8	7,745	n.	40	nw.	21	7	10	14	6.4	0.5	T.
St. Joseph	967	11	49	29.02	30.07	------	45.2	------	79	2	54	11	30	37	33	41	37	77	2.20	------	12	5,895	ne.	36	nw.	21	8	8	15	6.2	1.2	T.
Springfield, Mo	1,324	98	104	28.64	30.06	+.01	49.5	−8.7	84	3	58	19	28	39	32	45	42	81	2.82	0.0	12	6,976	se.	32	w.	21	7	8	16	6.0	0.2	0.0
Iola	984	11	50	29.00	30.06	+.02	49.0	−7.9	91	3	59	16	28	39	41	------	------	------	2.22	0.0	10	4,721	n.	27	n.	27	12	3	16	6.5	1.3	0.0
Topeka	987	92	107	------	------	------	47.2	−9.8	91	3	56	16	28	38	35	------	------	------	3.28	+1.4	9	6,303	n.	35	n.	27	9	7	15	6.2	0.1	0.0
Drexel	1,299	10	54	28.66	30.03	------	40.6	------	66	1	49	4	28	32	31	------	------	------	2.27	------	14	6,591	n.	30	s.	27	9	7	15	6.4	5.0	0.8
Lincoln	1,189	11	84	28.80	30.10	+.07	42.8	−11.4	70	3	51	3	30	34	32	38	33	73	1.52	−0.3	11	7,337	n.	37	nw.	10	8	3	16	6.7	4.5	T.
Omaha	1,105	115	122	28.89	30.09	+.06	42.7	−11.6	68	15	50	8	28	35	26	38	33	73	2.11	−0.2	14	6,414	nw.	32	nw.	37	2	6	17	6.7	5.8	0.2
Valentine	2,598	47	54	27.32	30.09	+.08	38.0	−11.3	65	5	48	−6	28	28	41	33	28	73	0.98	−0.3	12	6,985	nw.	34	nw.	21	8	6	16	6.5	9.3	0.3
Sioux City	1,135	94	164	28.86	30.11	+.09	39.4	−11.5	65	15	48	5	29	31	30	35	30	72	1.54	−0.2	10	8,610	nw.	40	s.	10	9	6	16	6.2	6.2	T.
Huron	1,306	59	74	28.69	30.13	+.12	36.8	−10.9	66	5	46	−6	29	27	33	31	26	70	0.23	−1.1	8	6,856	nw.	33	nw.	25	9	6	16	6.2	5.3	T.
Pierre	1,572	70	75	28.42	30.13	+.12	38.8	−11.0	64	10	48	−4	29	30	36	33	27	69	0.27	−0.5	6	6,538	nw.	39	nw.	5	9	6	16	6.2	2.2	T.
Yankton	1,233	49	57	28.75	30.10	+.09	39.6	−11.5	64	22	48	5	28	31	28	------	------	------	0.85	−0.7	9	5,406	nw.	28	s.	10	7	8	16	6.4	2.8	T
																															4.0	

TABLE I.—*Climatological data for Weather Bureau stations, October, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean mat. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	*F.*		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles.*								*0–10*	*In.*	*In.*
Northern Slope							**35.5**	**−8.8**										**76**	**1.65**	**+0.7**										**6.6**		
Billings	3,140	5		27.44	30.14	+.16	35.4	−9.1	68	21	45	−5	28	25	39	32	29	83	0.64	+0.1	10	4,298	e.	26	w.	21	6	12	13	6.0	2.1	0.0
Havre	2,505	11	44	27.44	30.14	+.16	35.4	−9.1	68	21	45	−5	28	25	39	32	29	83	0.64	+0.1	10	4,298	e.	26	w.	21	6	12	13	6.0	2.1	0.0
Helena	4,110	87	112	25.85	30.14	+.11	34.6	−10.3	62	4	43	5	27	26	31	31	28	81	2.78	+2.0	15	4,183	sw.	41	sw.	25	3	7	21	7.7	27.7	4.6
Kalispell	2,973	48	56	26.98	30.08	+.07	38.4	−5.1	65	21	48	15	27	29	32	34	28	69	0.69	−0.5	7	3,672	nw.	23	ne.	26	9	10	12	5.6	2.6	0.0
Miles City	2,371	48	55	27.57	30.18	+.18	35.6	−10.9	66	21	45	−8	28	27	36	31	27	73	0.71	−0.1	10	4,144	nw.	32	nw.	25	6	9	16	6.3	3.2	T.
Rapid City	3,259	50	58	26.65	30.16	+.15	35.1	−13.4	66	1	45	−13	28	25	44	30	26	71	1.56	+0.5	12	5,370	n.	32	n.	5	6	8	17	6.7	9.1	0.0
Cheyenne	6,088	84	101	23.98	30.05	+.04	37.8	−7.0	77	3	49	5	28	26	42	32	28	77	3.51	+2.8	14	7,906	s.	51	w.	25	8	7	16	6.8	14.6	0.5
Lander	5,372	60	68	24.64	30.08	+.04	37.5	−6.0	71	2	49	9	17	26	36	32	26	70	1.78	+0.7	10	2,931	sw.	32	nw.	25	7	11	13	6.3	12.7	T.
Sheridan	3,790	10	47	26.16	30.15	------	34.0	------	69	21	45	−1	28	23	39	30	26	78	3.20	------	15	3,389	nw.	38	nw.	25	5	12	14	6.8	20.1	4.2
Yellowstone Park	6,241	11	48	23.87	30.10	+.08	33.0	−8.5	65	4	44	3	27	22	37	29	25	78	2.46	+1.3	16	4,243	s.	30	nw.	25	3	10	18	7.0	23.4	3.5
North Platte	2,821	11	51	27.14	30.13	+.11	40.7	−9.0	73	21	51	4	28	30	35	35	31	76	0.76	−0.4	10	5,197	n.	35	nw.	25	8	5	18	6.9	4.8	T.
Middle Slope							**47.5**	**−8.4**										**74**	**1.58**	**0.0**										**5.9**		
Denver	5,292	106	113	24.72	30.03	+.02	43.3	−7.9	83	2	54	11	28	32	41	38	32	73	1.87	+0.9	15	5,060	n.	42	n.	25	7	10	14	6.3	10.5	0.0
Pueblo	4,685	80	86	25.28	30.00	+.01	46.9	−5.1	90	3	59	17	28	35	45	39	34	69	0.66	0.0	6	4,194	se.	24	nw.	25	9	14	8	5.5	1.7	0.0
Concordia	1,392	50	58	28.59	30.09	+.06	45.4	−10.5	81	3	54	15	28	37	34	40	35	72	1.21	−0.8	10	5,913	n.	30	n.	27	10	6	15	6.3	1.1	0.0
Dodge City	2,509	11	51	27.46	30.10	+.08	47.4	−8.7	88	3	58	15	28	37	41	41	37	77	1.29	−0.1	9	7,097	ne.	34	ne.	27	12	6	13	5.5	T.	0.0
Wichita	1,358	139	158	28.60	30.06	+.03	49.0	−9.6	89	3	58	19	28	40	37	44	39	75	1.33	−1.0	9	9,422	ne.	44	sw.	27	10	9	12	5.7	0.4	0.0
Broken Arrow	765	11	56	29.22	30.05	------	52.8	------	88	3	62	22	31	44	36	------	------	------	4.04	------	7	8,702	n.	43	n.	28	11	4	16	6.1	T.	0.0
Oklahoma City	1,214	10	47	28.76	30.06	+.03	53.2	−8.3	88	3	62	22	28	44	35	48	45	81	3.12	+1.3	6	7,191	n.	33	n.	28	8	8	15	5.8	T.	0.0
Southern Slope							**53.8**	**−4.3**										**75**	**2.11**	**+0.3**										**5.4**		
Abilene	1,738	10	52	28.21	30.02	+.01	60.6	−4.8	95	6	71	28	31	50	36	52	49	75	2.43	+0.1	7	6,254	s.	27	n.	28	11	7	13	5.7	0.0	0.0
Amarillo	3,676	10	49	26.29	30.04	+.04	50.2	−7.5	93	3	61	18	28	40	54	45	42	81	3.35	+1.0	8	7,322	n.	35	sw.	25	12	5	14	5.1	0.0	0.0
Del Rio	944	64	71	28.99	29.97	−.01	67.6	−2.3	90	4	75	37	31	60	26	------	------	------	1.72	−0.3	13	5,914	se.	37	nw.	15	8	9	14	6.6	0.0	0.0
Roswell	3,566	75	85	26.36	29.96	.00	57.0	−2.5	92	4	70	24	28	44	43	48	43	69	0.95	−0.3	6	5,172	s.	31	sw.	13	16	8	7	4.2	0.0	0.0
Southern Plateau							**59.3**	**−0.7**										**60**	**1.14**	**+0.6**										**4.2**		
El Paso	3,778	152	175	26.17	29.92	.00	64.4	+0.9	93	2	75	39	31	54	29	52	44	56	0.79	−0.2	8	6,870	e.	37	w.	15	13	15	3	4.2	T.	0.0
Santa Fe	7,013	38	53	23.24	29.91	−.05	49.6	−0.8	78	4	61	26	19	38	31	40	32	59	2.09	+1.0	9	4,245	se.	24	w.	23	18	5	8	3.5	1.5	0.0
Flagstaff	6,907	10	59	23.34	29.90	−.02	46.0	+1.3	72	1	59	25	25	33	40	37	------	63	2.40	------	8	5,354	w.	32	s.	5	16	10	5	----	T.	0.0
Phoenix	1,108	10	82	28.74	29.88	.00	68.4	−2.2	97	1	81	49	17	56	40	57	51	62	0.92	+0.6	8	2,858	e.	30	s.	5	13	10	8	4.3	0.0	0.0
Yuma	141	9	54	29.72	29.87	.00	70.2	−3.1	100	2	83	50	16	58	42	50	52	60	1.67	+1.5	3	2,830	w.	22	s.	24	19	7	5	3.3	0.0	0.0
Independence	3,957	5	26	25.92	29.93	−.92	57.4	−0.1	85	1	74	34	12	41	43	42	------	------	0.25	−0.1	2	------	nw.	----	------	----	18	7	6	2.5	0.0	0.0
Middle Plateau							**49.5**	**−0.7**										**54**	**1.53**	**+0.7**										**3.7**		
Reno	4,532	74	81	25.47	29.98	−0.1	49.8	+0.1	77	28	66	29	24	34	43	40	31	55	0.71	+0.4	6	3,430	w.	30	w.	6	23	3	5	2.5	T.	0.0
Tonopah	6,090	12	20	24.02	29.91	------	49.8	------	70	2	58	30	12	41	23	38	26	46	1.13	------	4	------	nw.	----	------	----	----	----	----	----	0.0	0.0
Winnemucca	4,344	18	56	25.62	30.03	−.02	47.2	−1.1	75	4	64	22	31	30	46	38	30	61	1.46	+0.9	4	4,185	ne.	28	sw.	5	20	5	6	3.4	0.0	0.0
Modena	5,479	10	43	24.60	29.95	−.01	46.9	−1.1	75	3	62	23	30	32	42	38	28	56	2.25	+1.4	7	6,470	w.	35	sw.	2	21	2	8	3.2	2.5	0.0
Salt Lake City	4,360	163	203	25.60	29.97	−.04	51.9	−0.6	78	2	61	34	24	43	29	42	31	50	0.73	−0.7	7	4,934	nw.	30	w.	23	13	9	9	4.8	0.0	0.0
Grand Junction	4,602	60	68	25.35	29.92	−.07	51.8	−1.0	85	2	64	28	25	40	43	42	33	56	2.50	+1.6	7	3,057	se.	22	s.	13	14	10	7	4.5	0.0	0.0
Northern Plateau							**48.9**	**−1.0**										**61**	**0.69**	**−0.5**										**4.9**		
Baker	3,471	48	53	26.47	30.06	−.02	45.8	−.08	70	21	59	25	30	33	38	39	33	63	0.36	−.06	3	4,021	se.	23	nw.	11	15	5	11	4.5	0.0	0.0
Boise	2,739	78	86	27.18	30.05	−.01	50.0	−1.1	70	4	60	31	24	40	33	44	37	65	2.14	+0.9	6	2,596	se.	26	s.	5	11	10	10	5.2	0.0	0.0
Lewiston	757	40	48	29.25	30.07	.00	50.6	−0.9	72	4	63	32	18	38	37	------	------	------	0.56	−0.6	8	1,353	w.	20	nw.	24	11	6	14	5.6	0.0	0.0
Pocatello	4,477	60	68	25.46	30.00	−.04	47.0	−1.4	74	4	59	21	17	35	38	38	31	60	0.63	−0.4	7	5,705	se.	37	sw.	25	14	8	9	4.7	T.	0.0
Spokane	1,929	101	110	28.00	30.07	+.01	46.1	−2.2	70	15	58	29	13	34	38	39	30	59	0.29	−1.2	3	2,789	ne.	26	sw.	24	9	10	12	5.4	T.	0.0
Walla Walla	991	57	65	28.97	30.04	−.03	53.8	+0.3	77	21	65	34	30	43	32	46	37	58	0.17	−1.3	4	2,685	s.	25	w.	24	16	8	7	4.1	0.0	0.0
North Pacific Coast Region							**52.8**	**+0.7**										**78**	**0.84**	**−2.9**										**5.8**		
North Head	211	11	56	29.86	30.09	+.04	53.8	+0.9	67	12	58	44	23	50	17	51	49	89	0.81	−3.1	8	7,186	n.	40	n.	9	9	6	16	6.4	0.0	0.0
Port Angeles	29	8	53	----	30.10	------	48.4	------	68	11	56	35	31	41	27	------	------	------	0.82	−1.8	6	3,251	s.	30	w.	24	11	7	13	----	0.0	0.0
Seattle	125	215	250	29.96	30.09	+.04	51.4	0.0	66	3	57	41	13	46	22	48	45	80	0.28	−2.4	4	4,189	n.	40	sw.	26	9	7	15	6.2	0.0	0.0
Tacoma	194	172	201	29.88	30.09	+.05	52.2	+1.7	68	7	60	39	14	45	24	------	------	------	0.19	−3.0	3	4,754	n.	41	s.	24	5	5	21	7.9	0.0	0.0
Tatoosh Island	86	9	53	29.99	30.08	+.07	50.2	+0.3	60	13	54	41	15	46	15	48	47	90	3.72	−4.3	7	7,946	e.	39	sw.	24	7	9	15	6.8	0.0	0.0
Yakima	1,071	5	----	----	----	----	51.2	------	78	16	68	24	18	35	50	------	------	------	0.14	------	4	------	nw.	----	------	----	14	10	7	4.3	0.0	0.0
Medford	1,425	4	----	----	----	----	52.0	------	81	21	69	29	30	35	47	43	36	62	0.29	------	1	------	se.	8	nw.	10	13	12	6	----	0.0	0.0
Portland, Oreg.	153	68	106	29.91	30.07	+.01	55.8	+1.6	78	4	64	38	24	47	30	51	47	76	0.02	−3.3	1	3,349	nw.	15	nw.	31	9	8	14	5.8	0.0	0.0
Roseburg	510	9	57	29.52	30.08	.00	53.6	−0.3	79	21	67	33	13	40	39	48	42	71	0.05	−2.6	3	1,404	n.	12	nw.	12	19	10	2	3.4	0.0	0.0
Middle Pacific Coast Region							**59.9**	**+0.5**										**68**	**0.44**	**−1.0**										**3.6**		
Eureka	62	73	89	29.97	30.04	−.02	53.9	+0.3	75	20	60	44	24	48	27	51	49	86	0.95	−1.7	4	2,978	se.	29	nw.	25	11	7	13	5.3	0.0	0.0
Point Reyes	490	7	18	29.41	29.92	------	56.9	+2.2	78	21	63	48	20	51	29	------	------	------	T.	------	0	9,174	nw.	50	nw.	11	10	11	10	5.3	0.0	0.0
Red Bluff	332	50	56	29.59	29.95	−.06	63.6	−0.7	89	20	78	41	17	49	43	52	41	50	0.46	−1.1	2	3,571	nw.	24	nw.	24	26	2	33	1.9	0.0	0.0
Sacramento	69	106	117	29.86	29.93	−.06	62.6	−0.3	87	20	75	42	17	50	35	54	46	62	T.	−1.0	0	4,222	s.	23	s.	10	24	6	1	1.5	0.0	0.0
San Francisco	155	208	243	29.80	29.96	−.05	62.2	+1.7	85	20	69	52	18	55	30	55	51	75	0.31	−1.0	4	5,140	w.	28	w.	11	14	13	4	4.0	0.0	0.0
San Jose	141	12	110	29.81	29.96	------	60.3	0.0	85	25	73	42	14	48	39	----	----	----	0.48	−0.2	3	3,569	nw.	25	ne.	25	14	13	4	3.5	0.0	0.0
South Pacific Coast Region							**53.2**	**−0.4**										**70**	**1.64**	**+0.8**										**3.8**		
Fresno	327	89	98	29.56	29.92	−.04	63.4	−0.6	85	21	76	45	18	51	32	53	45	58	1.79	+1.1	5	3,509	nw.	30	nw.	5	23	5	3	2.2	0.0	0.0
Los Angeles	338	159	191	29.58	29.95	.00	65.0	−0.3	90	20	73	51	13	57	30	57	53	72	0.74	0.0	3	3,492	sw.	21	sw.	5	17	9	5	3.8	0.0	0.0
San Diego	87	62	70	29.85	29.94	−.01	63.6	−0.1	76	1	70	50	2	58	22	59	56	81	3.67	+3.2	5	3,886	nw.	25	e.	5	7	17	7	5.5	0.0	0.0
San Luis Obispo	201	32	40	29.76	29.98	−.01	61.0	−0.8	91	25	74	42	2	48	41	52	47	71	0.37	−1.0	4	2,425	nw.	16	ne.	19	18	9	4	3.6	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.86	29.94	------	79.8	0.0	88	22	85	72	3	74	15	----	----	----	4.37	−1.7	19	7,345	e.	39	e.	16	6	20	5	5.3	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.70	29.82	−.02	80.4	+1.2	91	12	87	72	27	74	16	76	75	91	7.37	−3.0	19	4,048	nw.	26	ne.	9	0	9	22	8.0	0.0	0.0
Colon	36	7	97	29.79	29.83	−.01	81.3	+1.5	89	14	87	72	3	76	16	77	76	90	16.49	+0.9	22	5,611	w.	26	ne.	25	0	7	24	8.4	0.0	0.0
Alaska																																
Juneau	80	11	54	----	----	----	45.4	------	61	17	49	31	28	42	15	43	40	84	8.92	------	23	4,963	s.	34	se.	19	3	1	27	8.9	2.5	0.0
Hawaiian Islands																																
Honolulu	38	86	100	----	----	----	77.2	------	84	21	82	70	11	72	14	70	67	73	2.47	+0.9	12	4,934	e.	26	e.	6	13	16	2	4.1	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, October, 1925*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*In.*	*In.*	*In.*
St. Johns, N. F.	125												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	29.78	29.80	−0.15	36.5	−3.5	41.3	31.8	52	16	3.94	+1.04	13.8
Quebec, Que.	296	29.55	29.88	−.12	38.1	−4.3	43.5	32.7	57	22	2.72	−0.43	4.8
Montreal, Que.	187	29.68	29.89	−.12	40.0	−4.8	46.0	34.1	59	22	4.00	+0.87	3.2
Stonecliffe, Ont.	489												
Ottawa, Ont.	336	29.66	29.93	−.08	40.0	−3.8	48.7	31.4	64	16	2.42	−0.13	5.1
Kingston, Ont.	285	29.63	29.95	−.08	42.0	−5.0	48.7	35.4	62	22	3.73	+1.00	0.9
Toronto, Ont.	379	29.56	29.98	−.06	42.3	−4.3	49.2	35.5	65	24	2.62	+0.26	4.2
Cochrane, Ont.	930				30.8		36.6	25.1	52	8	1.84		5.5
White River, Ont.	1,244	28.58	29.93	−.05	30.9	−6.2	37.7	24.1	54	10	1.74	−0.61	2.0
Port Stanley, Ont.	592												
Southampton, Ont.	656	29.24			40.6	−5.5	47.1	34.0	65	18	4.32	+1.15	4.7
Parry Sound, Ont.	688	29.23	29.93	−.08	38.7	−5.2	45.6	31.8	65	16	5.21	+1.29	17.3
Port Arthur, Ont.	644	29.26	29.97	−.01	36.0	−3.9	42.0	30.0	58	10	1.28	−1.28	0.0
Winnipeg, Man.	760	29.18	30.05	+.07	33.0	−6.1	39.5	26.5	57	6	1.34	−0.36	9.3
Minnedosa, Man.	1,690	28.17	30.04	+.07	29.4	−8.4	35.9	22.8	50	−.3	1.02	−0.18	9.6
Le Pas, Man.	860				28.5		35.9	21.2	57	−.5	1.14		9.0
Qu'Appelle, Sask.	2,115	27.75	30.06	+.09	28.8	−10.6	36.4	21.2	51	−.1	0.95	−0.15	5.0
Medicine Hat, Alb.	2,144												
Moose Jaw, Sask.	1,759				31.9		40.8	23.1	56	0	0.46		2.4
Swift Current, Sask.	2,392	27.53	30.13	+.16	30.6	−11.5	39.2	22.0	59	−.6	0.90	+0.02	8.5
Calgary, Alb.	3,428												
Banff, Alb.	4,521												
Edmonton, Alb.	2,150												
Prince Albert, Sask.	1,450	28.48	30.10	+.13	31.7	−5.4	40.0	23.4	56	2	0.66	−0.17	2.3
Battleford, Sask.	1,592	28.32	30.11	+.14	32.4	−7.2	43.1	21.8	65	2	0.98	+0.53	4.0
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.84	30.10	+.09	50.3	+1.1	55.9	44.8	66	39	1.14	−1.23	0.0
Barkerville, B. C.	4,180												
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.92	30.06	+.06	73.7	+0.7	79.5	68.0	84	62	4.73	−1.98	0.0

LATE REPORTS, SEPTEMBER, 1925

Sydney, C. B. I.	48	29.92	29.97	−.04	54.3	−2.2	63.7	44.9	80	32	5.41	+2.13	0.0
Halifax, N. S.	88	29.88	29.98	−.06	57.7	+0.1	67.2	48.2	82	35	2.36	−1.35	0.0
Yarmouth, N. S.	65	29.89	29.96	−.09	54.5	−1.6	61.0	47.9	71	35	2.98	−0.47	0.0
Charlottetown, P. E. I.	38	29.90	29.94	−.07	54.9	−2.4	60.6	49.3	71	38	1.69	−1.71	0.0
Chatham, N. B.	28	29.87	29.90	−.10	52.2	−3.2	61.3	43.1	78	30	3.92	+1.21	0.0
Battleford, Sask.	1,592	28.28	30.02	+.12	53.6	+1.8	66.6	40.7	88	24	1.41	+0.16	0.0
Kamloops, B. C.	1,262	28.70	29.99	+.02	56.7	−0.7	67.5	45.9	80	34	1.10	+0.25	0.0
Barkerville, B. C.	4,180	25.69	30.00	+.02	43.0	−3.7	52.8	33.3	69	20	3.36	+0.45	1.7
Calgary, Alb.	3,428	26.46	30.04	+.12	48.7	−1.1	58.7	38.7	83	25	5.08	+3.72	32.3
Winnipeg, Man.	760	29.12	29.99	+.05	55.9	+3.4	66.6	45.3	92	32			

Chart I. Tracks of Centers of Anticyclones, October, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

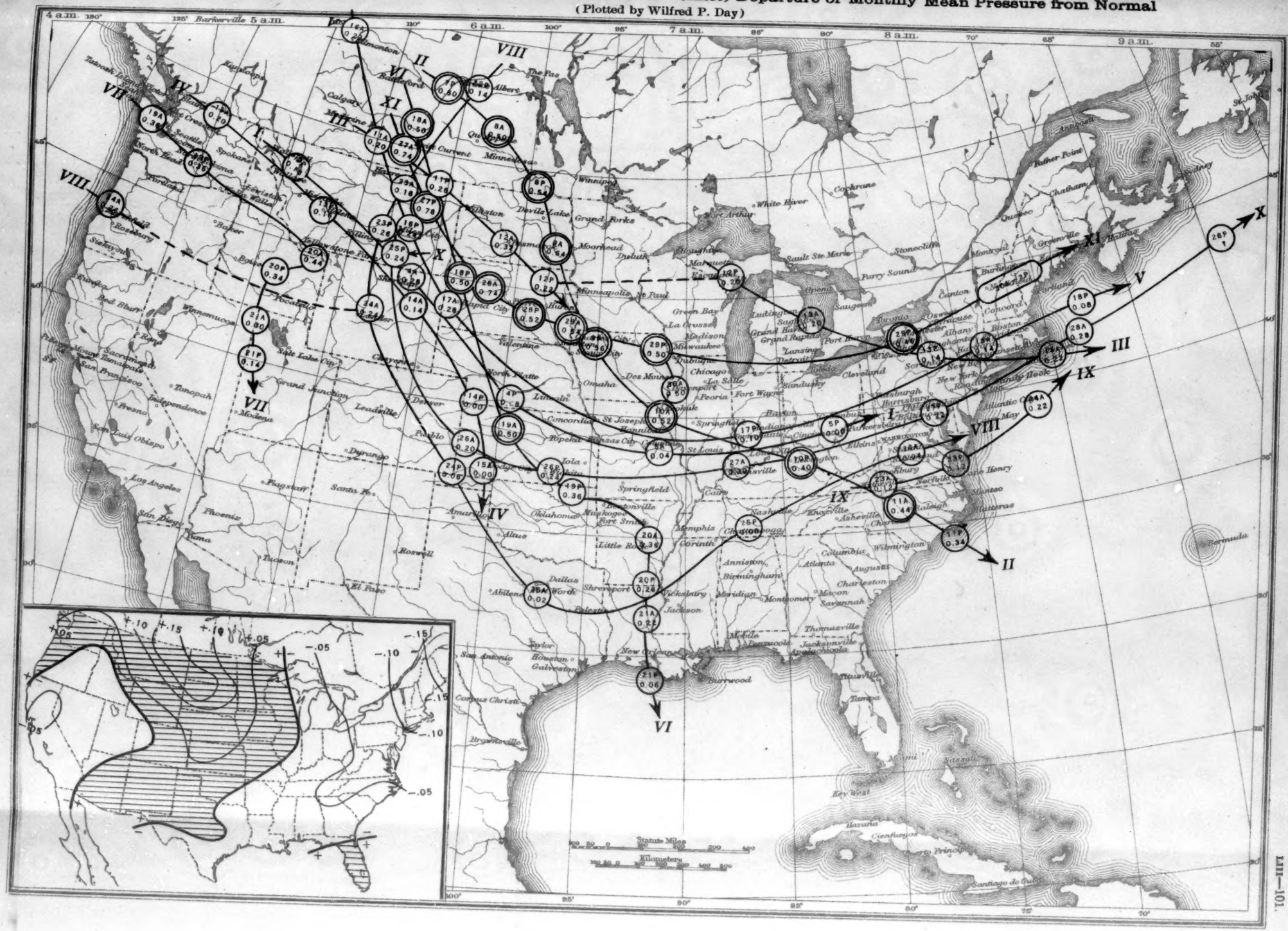

Chart II. Tracks of Centers of Cyclones, October, 1925. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

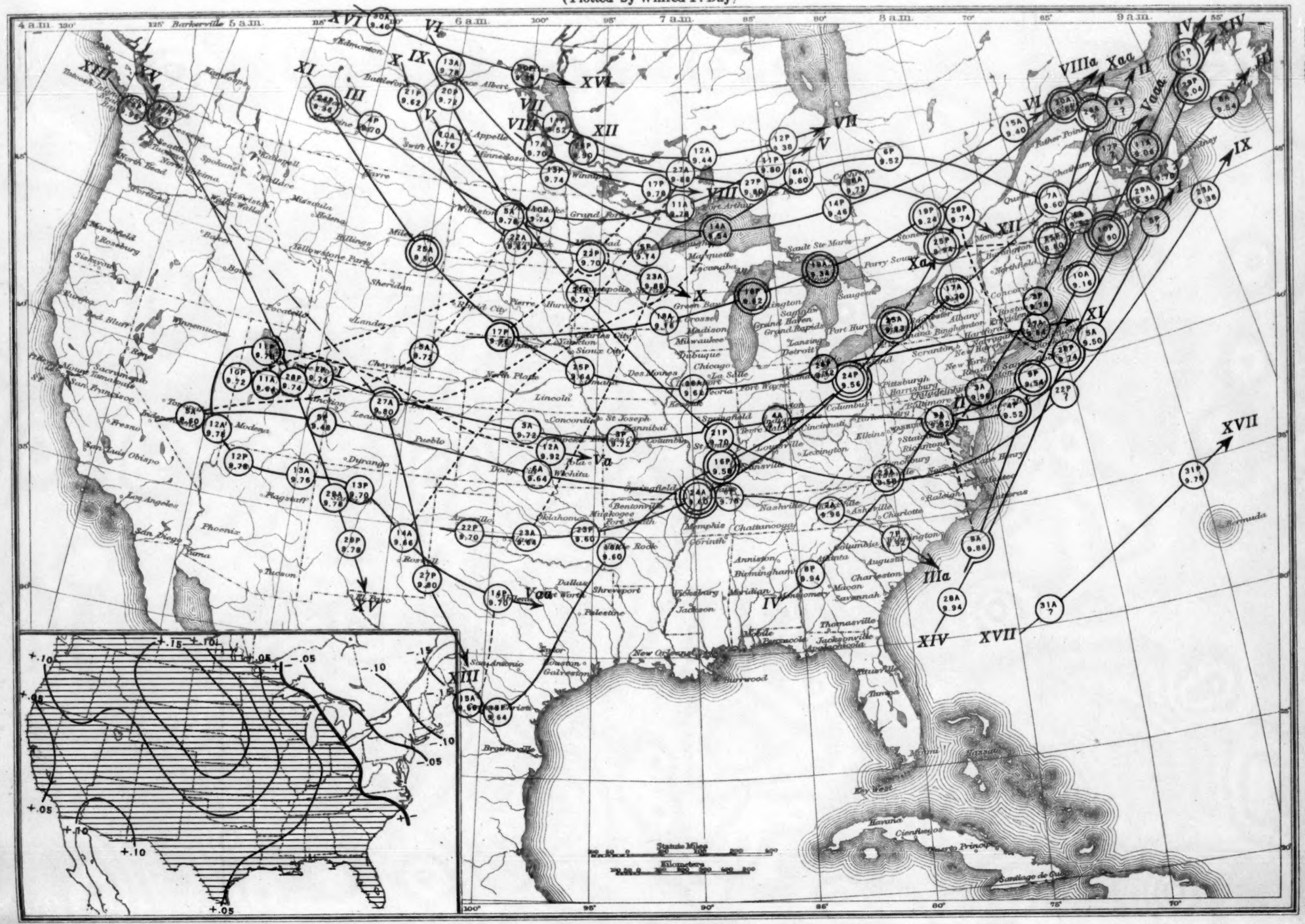
4 a.m.
5 a.m.
6 a.m.
7 a.m.
8 a.m.
9 a.m.
Barkerville
Edmonton
Kamloops
Swift Current
Minnedosa
Winnipeg
Prince Albert
Battleford
Moose Jaw
Medicine Hat
Calgary
Lethbridge
Havre
Helena
Miles City
Billings
Yellowstone Park
Sheridan
Bismarck
Williston
Devils Lake
Grand Forks
Pierre
Huron
Aberdeen
Rapid City
Valentine
Omaha
Norfolk
Concordia
St Joseph
Kansas City
Springfield
Columbia
Cairo
Dodge City
Wichita
Oklahoma City
Amarillo
Roswell
Abilene
Dallas
Fort Worth
Shreveport
Palestine
Houston
Galveston
San Antonio
Del Rio
El Paso
Tucson
Phoenix
Yuma
San Diego
Los Angeles
San Luis Obispo
Fresno
Modena
San Francisco
Sacramento
Red Bluff
Roseburg
Marshfield
Portland
Walla Walla
Lewiston
Spokane
Wallace
Kalispell
Missoula
Helena
Boise
Winnemucca
Reno
Tonopah
Independence
Flagstaff
Durango
Pueblo
Denver
Lander
Chevenne
North Platte
Grand Island
Lincoln
Des Moines
Dubuque
Green Bay
Madison
Milwaukee
Chicago
La Salle
Peoria
Fort Wayne
Grand Rapids
Port Huron
Lansing
Detroit
Toledo
Cleveland
Buffalo
Rochester
Albany
Binghamton
Scranton
Harrisburg
Pittsburgh
Philadelphia
Baltimore
New York
Columbus
Cincinnati
Indianapolis
Louisville
Lexington
Evansville
Springfield
St Louis
Nashville
Memphis
Chattanooga
Knoxville
Asheville
Charlotte
Raleigh
Norfolk
Washington
Richmond
Atlanta
Augusta
Charleston
Savannah
Montgomery
Birmingham
Meridian
Vicksburg
Jackson
Corinth
Little Rock
Fort Smith
Bentonville
Muskogee
Texarkana
Shreveport
Dallas
Abilene
Roswell
Amarillo
Dodge City
Wichita
Oklahoma City
Concordia
St Joseph
Kansas City
Springfield
Columbia
Cairo

Chart III. Departure (°F.) of the Mean Temperature from the Normal, October, 1925

Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart IV. Total Precipitation, Inches, October, 1925. (Inset) Departure of Precipitation from Normal

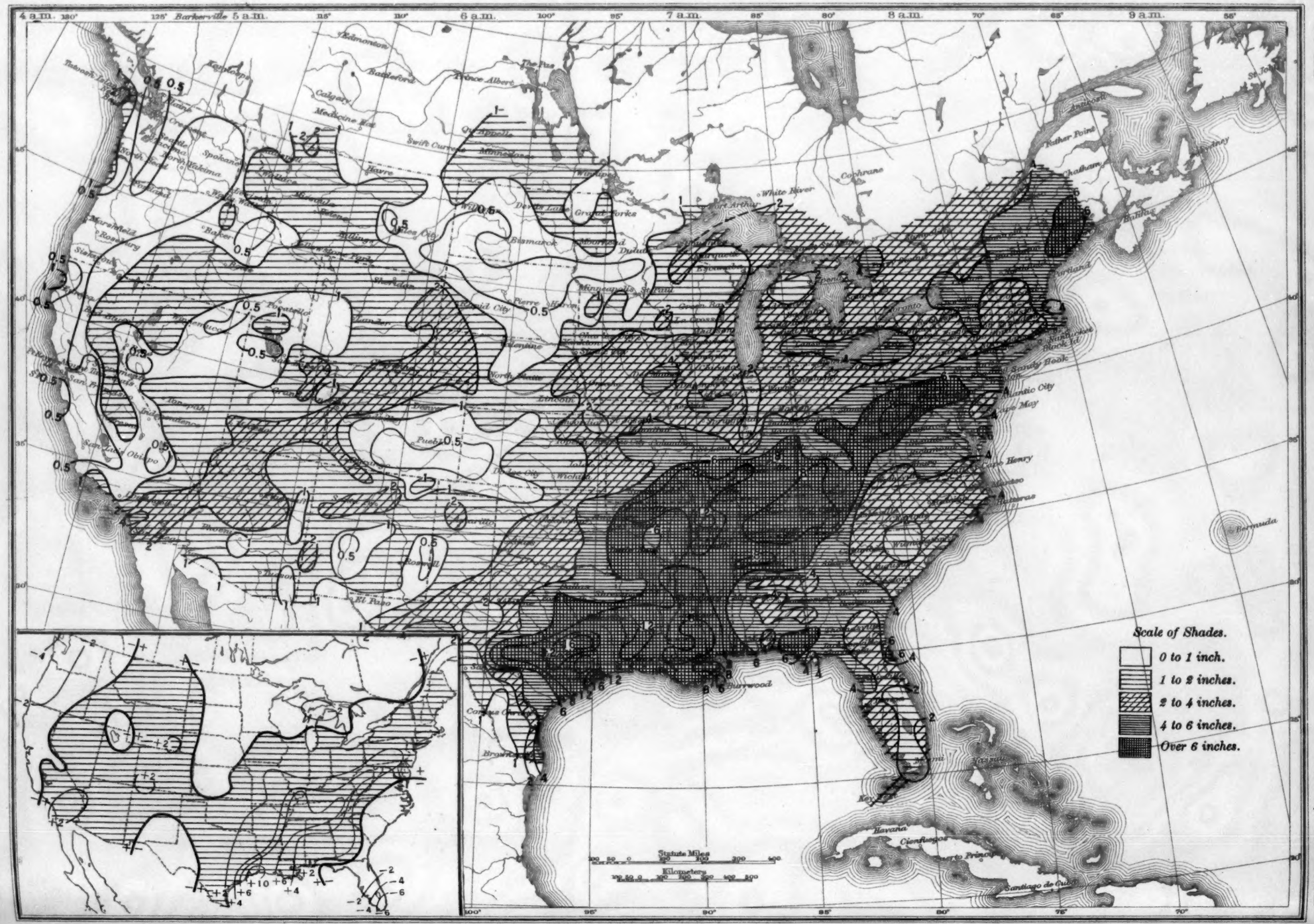

Chart V. Percentage of Clear Sky between Sunrise and Sunset, October, 1925

Chart V. Percentage of Clear Sky between Sunrise and Sunset, October, 1925

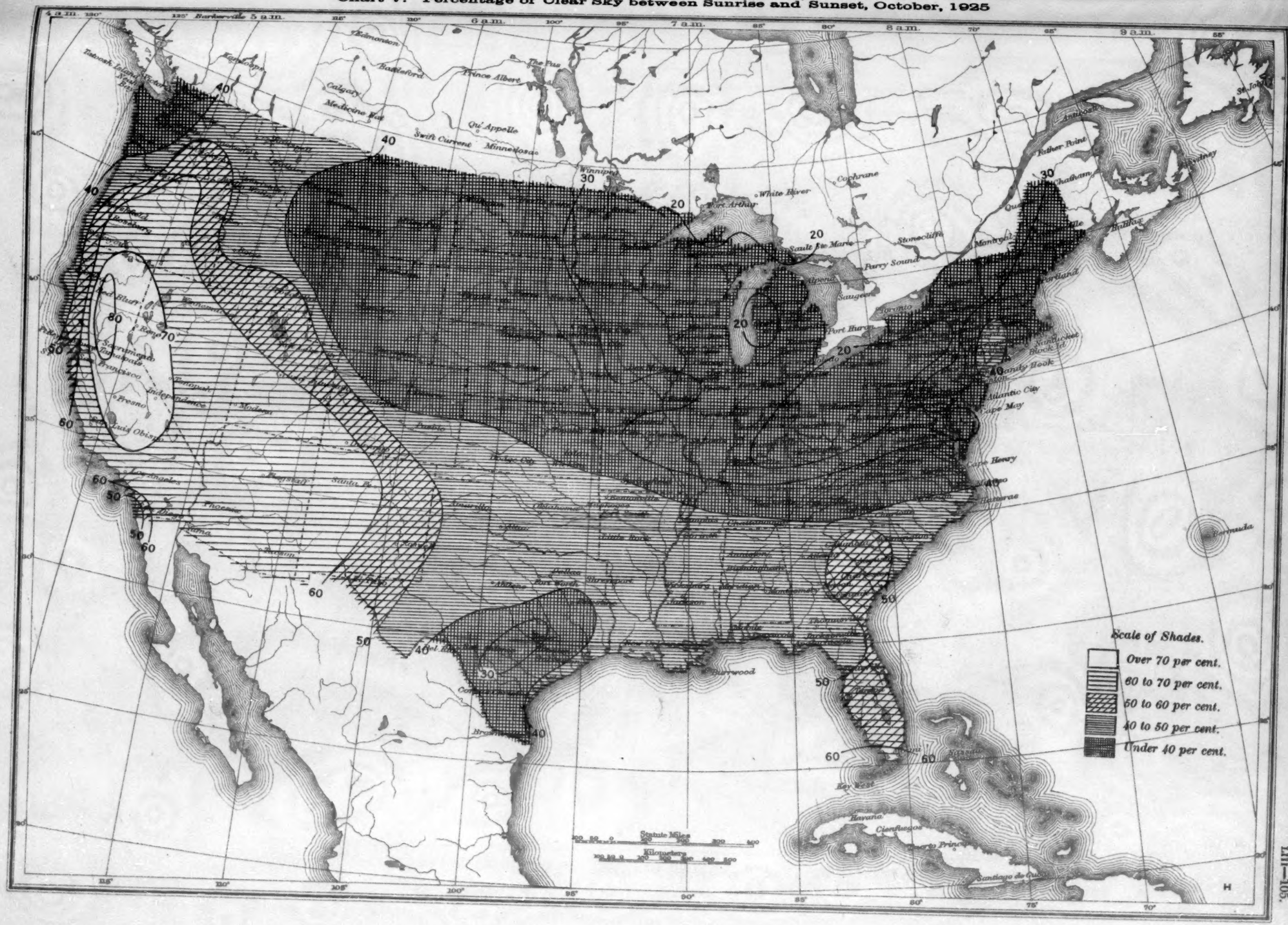

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, October, 1925

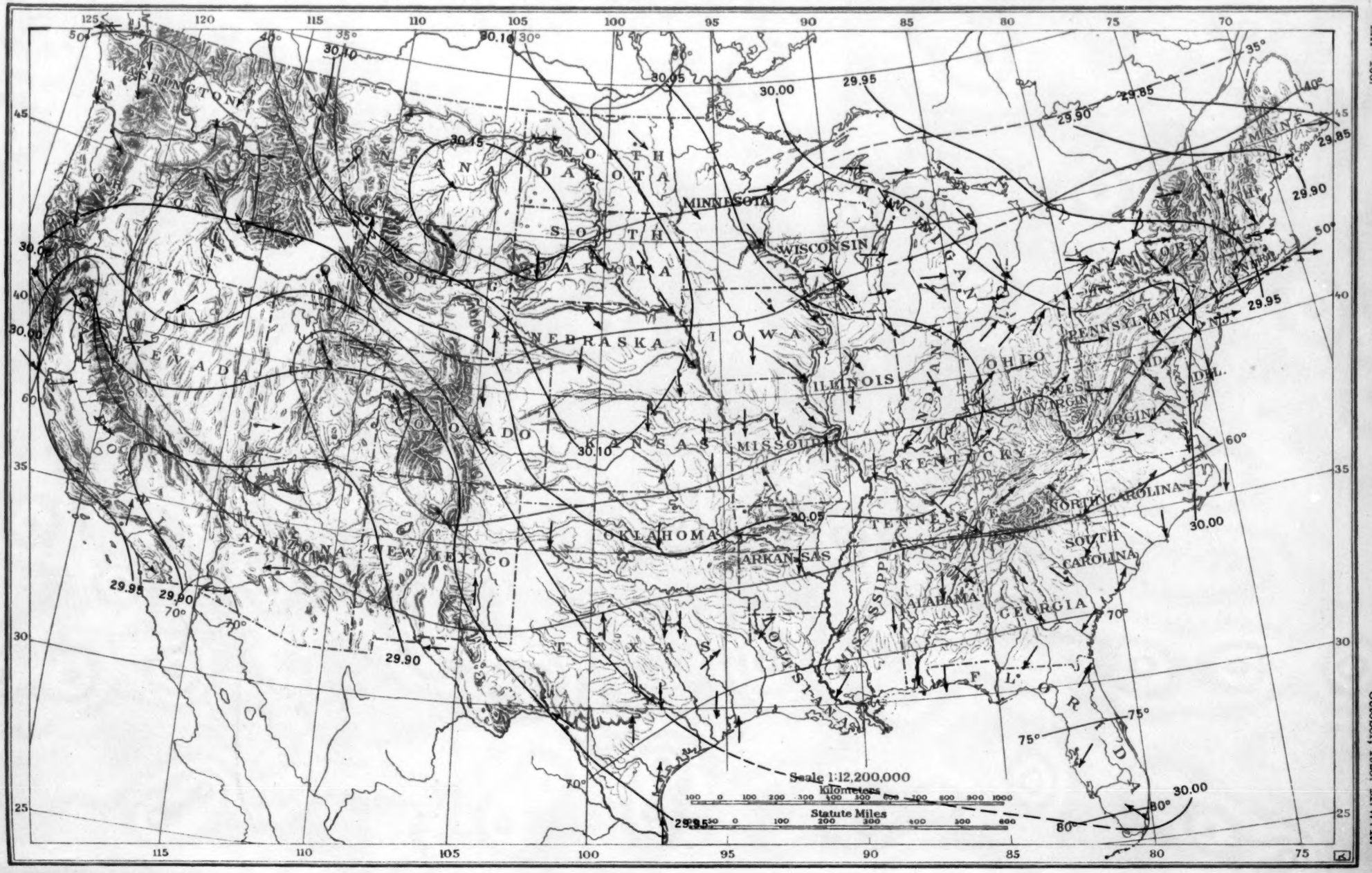

Chart VII. Total Snowfall, Inches, October, 1925.

Chart VII. Total Snowfall, Inches, October, 1925.

Chart VIII. Weather Map of North Atlantic Ocean, October 10, 1925

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Chart VIII. Weather Map of North Atlantic Ocean, October 10, 1925
(Plotted by F. A. Young)

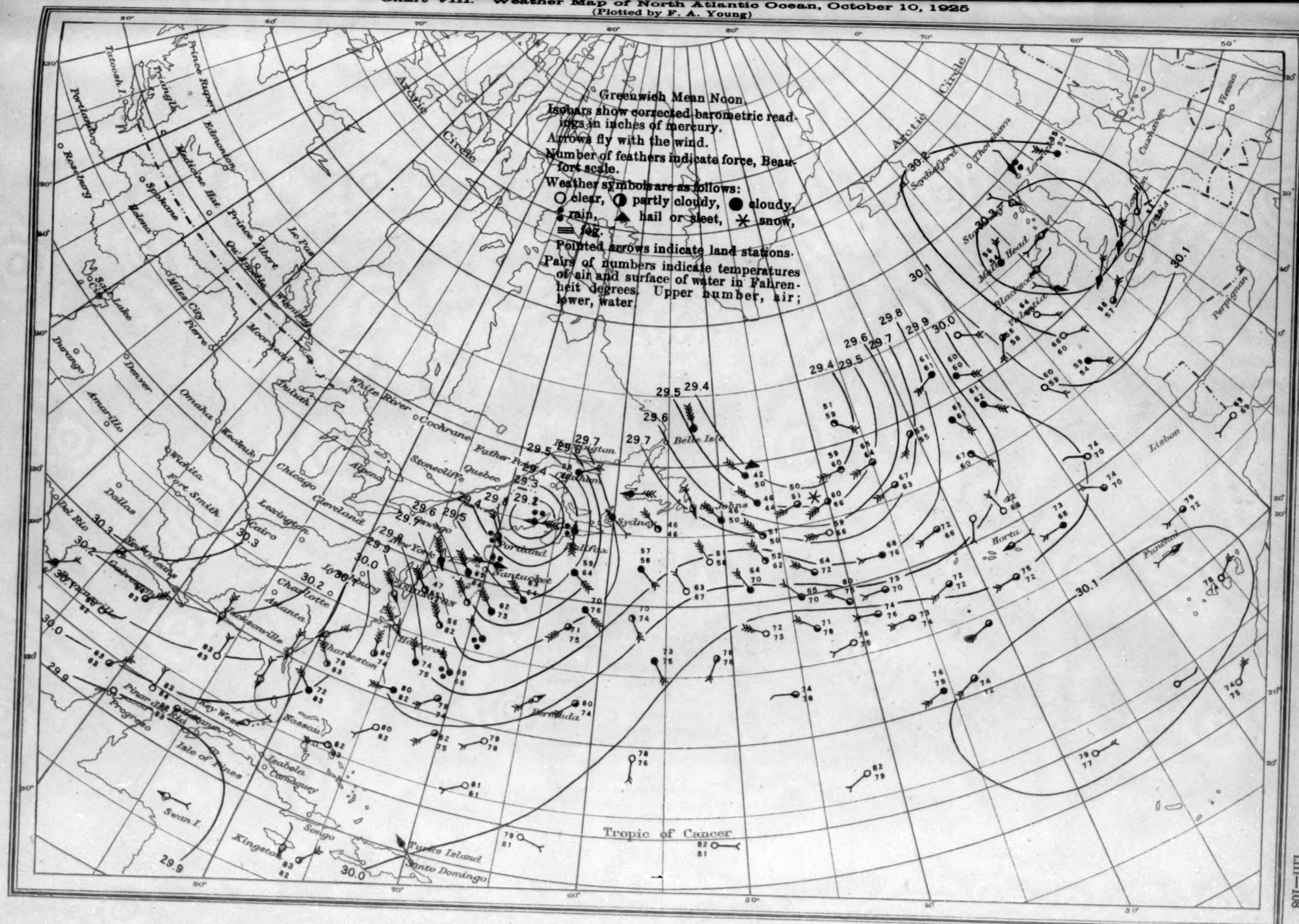


Chart IX. Weather Map of North Atlantic Ocean, October 11, 1925

(Plotted by F. A. Young)

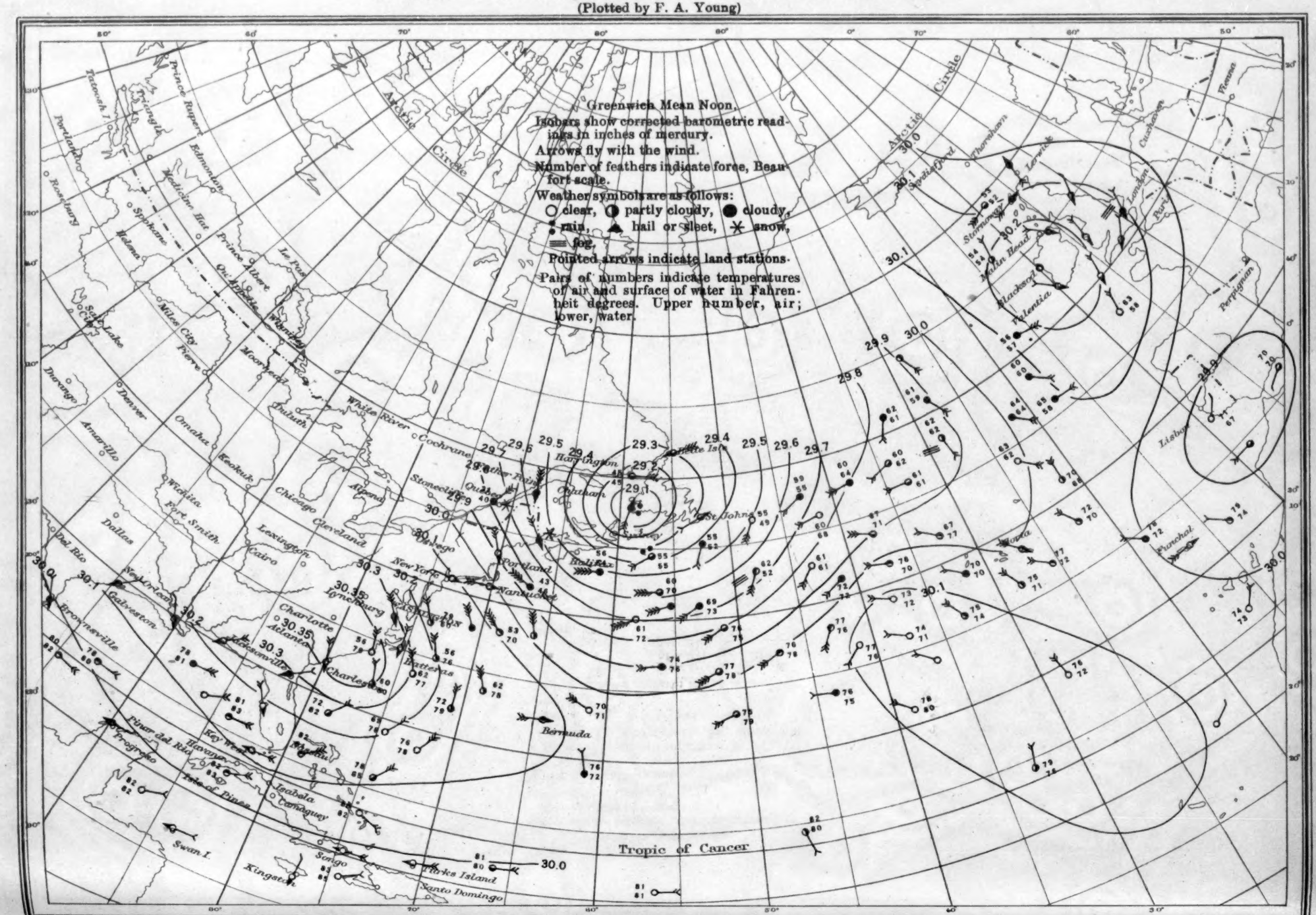


Chart X. Weather Map of North Atlantic Ocean, October 19, 1925

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, October 19, 1925
(Plotted by F. A. Young)

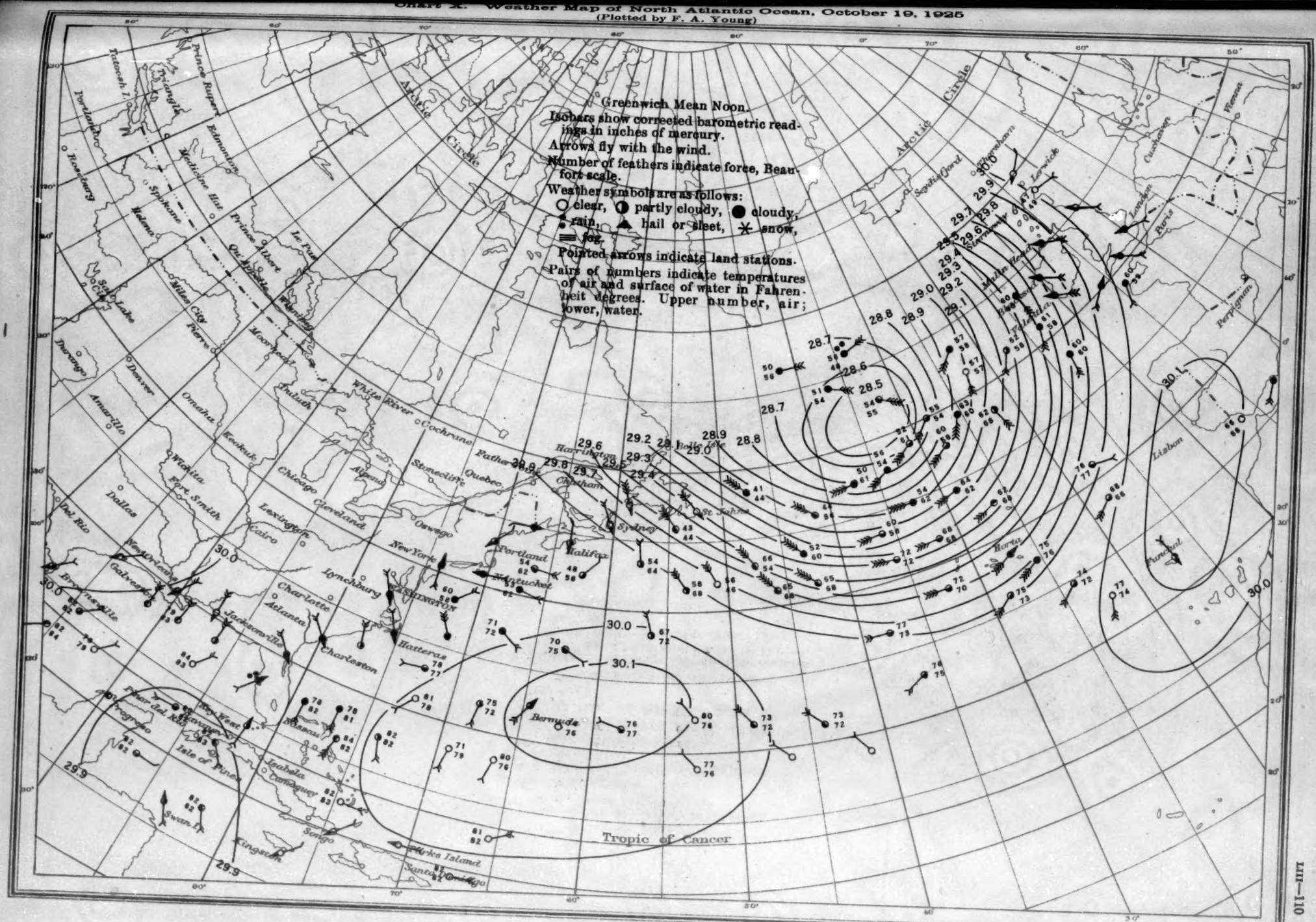


Chart XI. Weather Map of North Atlantic Ocean, October 20, 1925

(Plotted by F. A. Young)

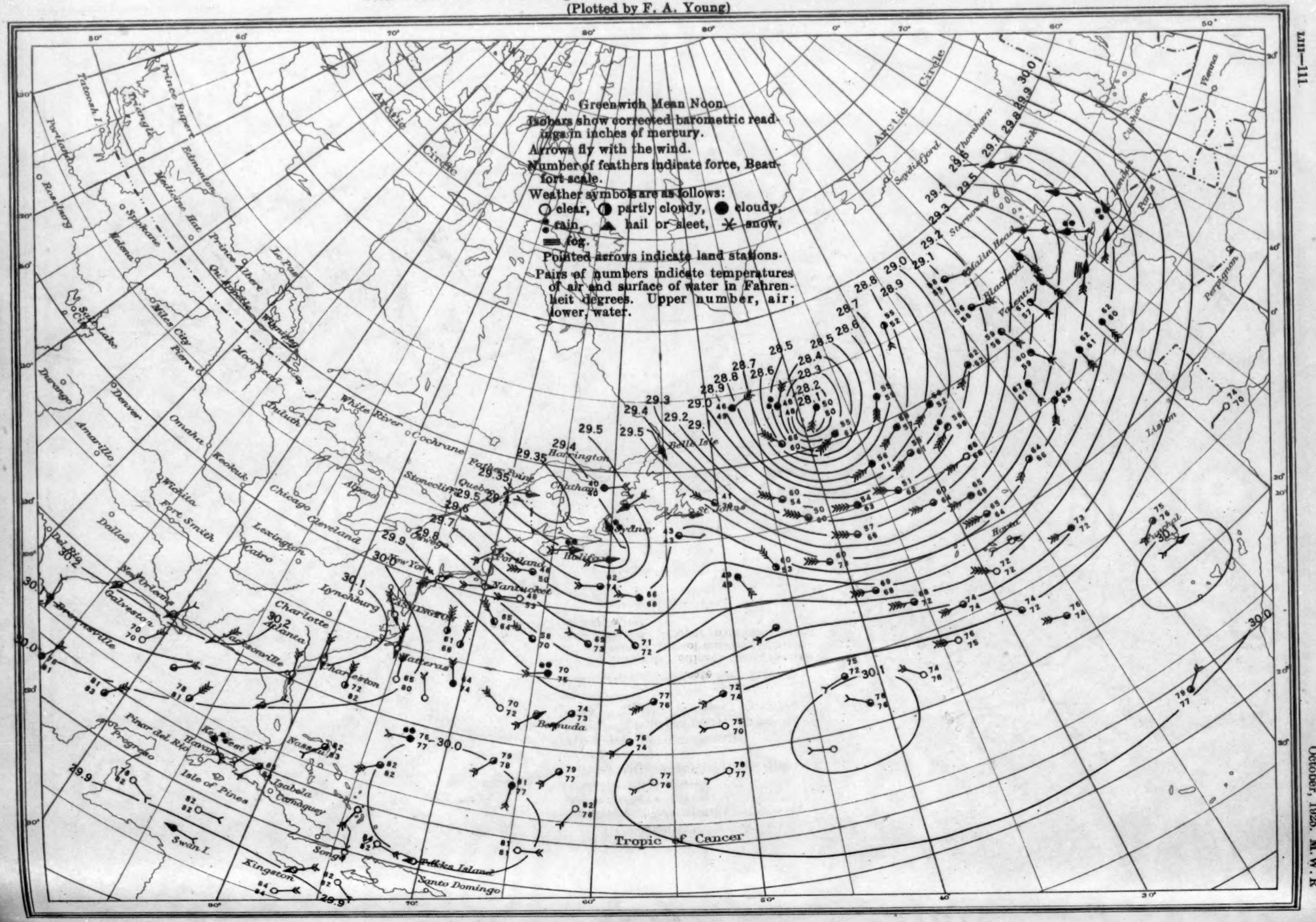


Chart XII. Weather Map of North Atlantic Ocean, October 21, 1925

(Plotted by F. A. Young)

Chart XII. Weather Map of North Atlantic Ocean, October 21, 1925

(Plotted by F. A. Young)

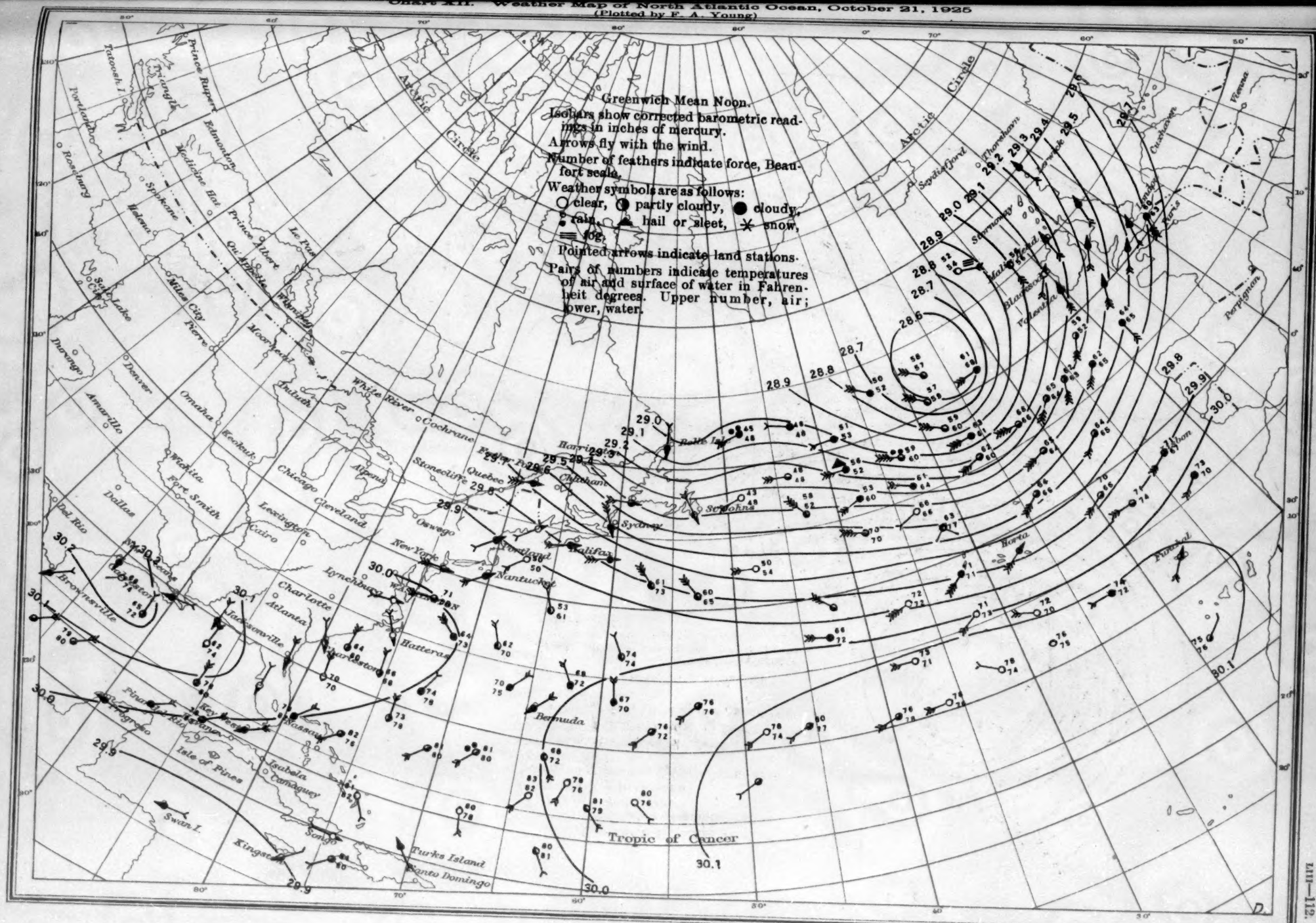
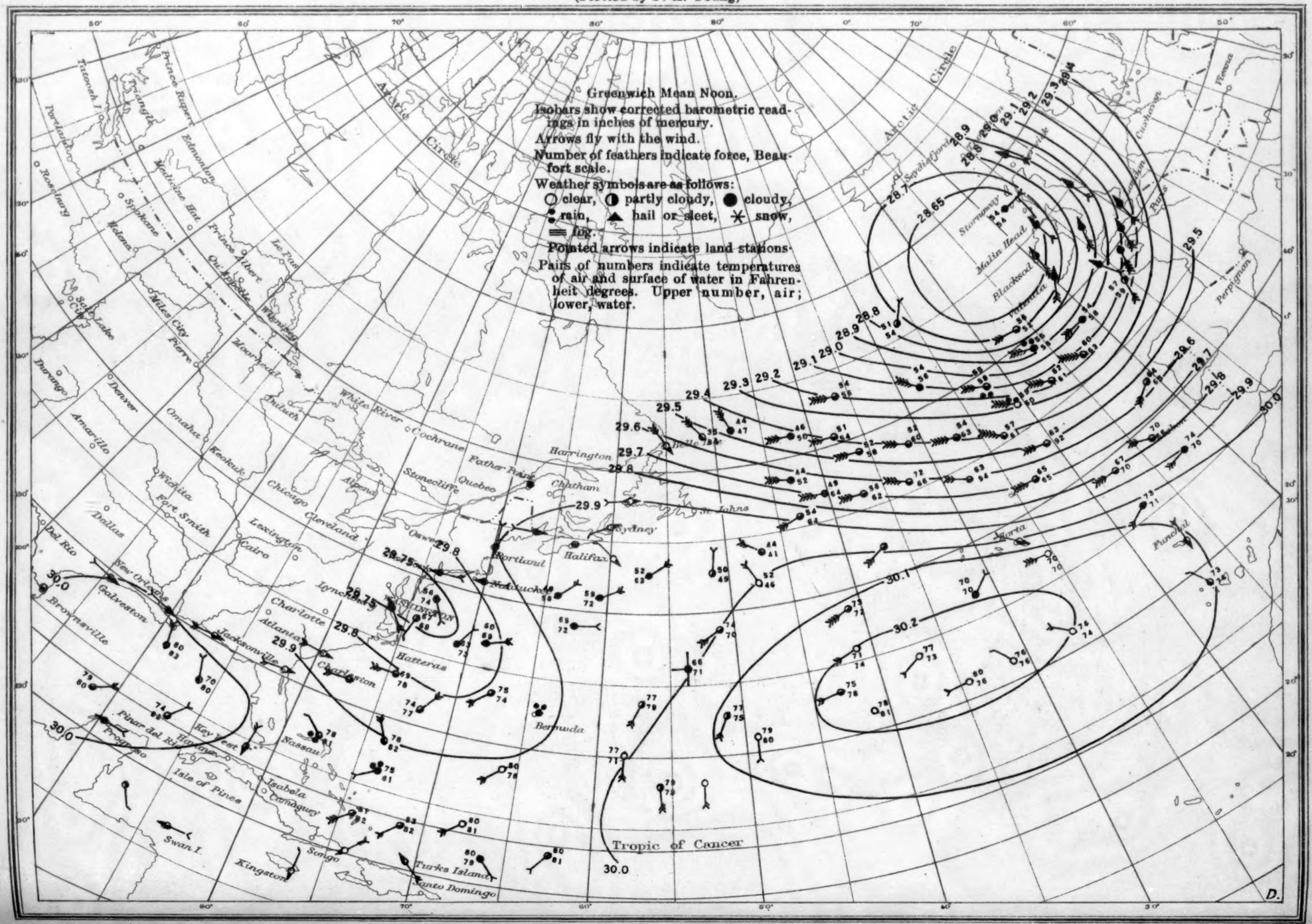


Chart XIII. Weather Map of North Atlantic Ocean, October 22, 1925

(Plotted by F. A. Young)


Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail or sleet, snow,
fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Arctic Circle
Tropic of Cancer
30.0
D.